Everyday Mechanics

TRADE MARK REGISTRATION APPLIED FOR

"It Tells You How to Make and How to Do Things"

VOL. 1 MARCH, 1916 No. 3

IMPORTANT

The great Popular Mechanics Magazine of Chicago has entered suit against your new EVERYDAY MECHANICS *for damages, alleging that your little magazine bears such a close resemblance to Popular Mechanics Magazine in make-up, contents, name and general appearance that the new magazine is likely to deceive "the ordinary purchaser."*

The substance of the complaint of Popular Mechanics Company is to the effect that Everyday Mechanics Co., Inc., has deliberately designed, advertised, published and distributed a magazine with the "intent to reap the advantages, benefits and profits of the credit and reputation of Popular Mechanics Magazine by a close simulation thereof."

EVERYDAY MECHANICS *is the conception of one man who has the interests of but one class of readers at heart. These readers are the serious-minded experimenters, both young and old, who have done so much and are doing so much to better the conditions of everyday life through their devotion to Science and Invention.*

Before EVERYDAY MECHANICS *was started, its Editor offered "the idea" to Mr. H. H. Windsor, Publisher of Popular Mechanics Magazine, for use as a department in that estimable publication. After several months of consideration, the entire propaganda as suggested, was declined by Mr. Smisor, the Shop Notes Editor of Popular Mechanics Magazine.*

Then, and not until then, the plans for your new magazine were definitely formulated, although the name, EVERYDAY MECHANICS *had been devised months before that time. The first announcement, in the form of a circular and form letter from the Editor, was shortly afterward distributed.*

In this advertising literature great stress was laid upon the fact that the new magazine was to be totally different from anything in the field; that it was to be purely a "how-to-make-it" magazine with a clearly defined and closely followed policy that would stamp it at once as something unique.

In the December 4th issue of "The Editor," a magazine for writers, the following statement appears in the announcement of the editorial requirements of EVERYDAY MECHANICS: *"We shall have no use for subjects of general mechanical interest, such as photographs of new machines, 'publicity write-ups' of new devices, general news features in the mechanical world, etc. I mention this because our office has already been flooded with material similar to that used by "Popular Mechanics," "Popular Science Monthly," "Scientific American" and kindred publications. Our requirements are lucidly but briefly stated in our slogan "It Tells You How to Make and How to Do Things."*

The spirit of this announcement has been incorporated in every advertising announcement, every editorial, every piece of literature that has been issued from the office of EVERYDAY MECHANICS. *The Editor and the Publishers have used every means in their power to prevent possible confusion with the esteemed Popular Mechanics Magazine, as it was far from their hopes, ambitions and the dictates of their good business sense to enter a field so crowded with magazines of reputation and standing.*

In the face of all this, Popular Mechanics Company alleges that EVERYDAY MECHANICS *has done it damage to the extent of $10,000. The peculiar part of it is that in its complaint, Popular Mechanics Company specifically states that its distribution is principally through the medium of the 36,000 news-dealers of the country. When the complaint was filed* EVERYDAY MECHANICS *had been on the news-stands of one city alone—New York City—for but a few days. The circulation of* EVERYDAY MECHANICS *at the time was, and is now, largely a circulation based upon subscriptions sent through the mails; it was bought by people who knew definitely just what they were buying and the reason why they were buying it.*

The men back of EVERYDAY MECHANICS *believed that they were in the right; that if competition existed between their magazine and Popular Mechanics Magazine, the competition was fair and just; that if a Popular Mechanics reader bought* EVERYDAY MECHANICS *he bought it because the new magazine contained material that Popular Mechanics Magazine did not contain, never has contained, and, in part, never will contain, simply because the author of the material will not sell it to Popular Mechanics Magazine.*

Just to prove to their own satisfaction that they were right, however, the Editor and Publishers sent out a form letter to the list of EVERYDAY MECHANICS *readers insofar as was possible. The replies were immediate and their tone significant. This form letter and just a few of the interesting responses will be found in the section of this number entitled "A Chat with the Editor."*

We believe we are in the right and that there is such a thing as justice in the land. If you, as a reader, think we are not right, tell us about it; and if you think we are right, also tell us. We want to know whether we are making good with the reader—that is what counts. We want to know if there is such a resemblance between our magazine and Popular Mechanics Magazine—or any other magazine published—that you would be deceived into buying ours thinking it was the other. If you like your new magazine and want to see it succeed and grow in spite of all of the many obstacles that are inevitably thrown in the path of the "little feller" with a big idea, just drop us a line.

Thomas Stanley Curtis

YOUR EDITOR.

IMPORTANT

Owing to the lateness of the February number of EVERYDAY MECHANICS, the forms for which were held pending the preparation of the statement relative to the Popular Mechanics action, the current issue is dated March instead of February, while the serial number is, of course, consecutive.

All subscribers of record at this date will receive the full twelve numbers; the subscriptions expiring in December, 1916, for instance, will be extended to January, 1917.

In view of the changes in dating, the Movie Camera Contest will, of course, be extended one month, the winner's name appearing in the April number.

contact post. The taps go, of course, to the intermediate posts. The central post, to which the plug is connected with cables, is connected with the second binding post.

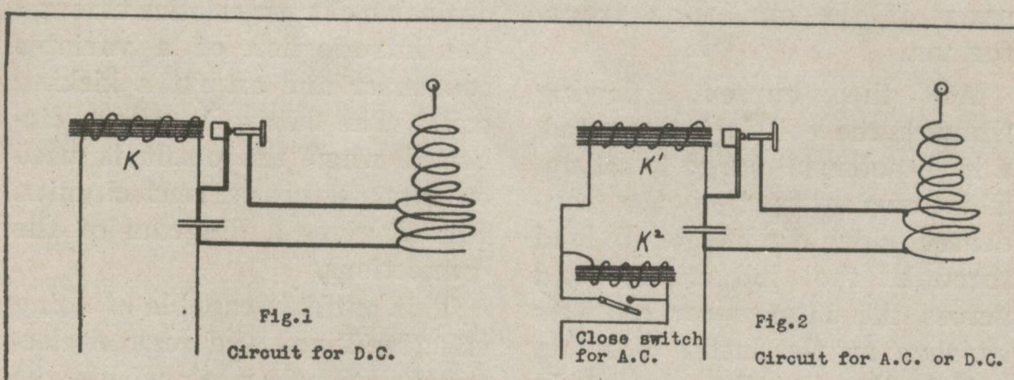
The construction of the upright for the secondary is clearly shown in the drawings and the photographs. The base portion slides between the rails on the main base, passing beneath the primary support when the secondary coil is within the primary.

The finish of the woodwork is, of course, optional with the individual. The model illustrated is stained a weathered oak and finished with wax. This color harmonizes well with the green silk covering of the wire. The latter is given several coats of shellac, each coat being permitted to dry thoroughly before the next is applied.

THE CONSTRUCTION OF KICKING COIL HIGH FREQUENCY APPARATUS

By The Laboratory Staff

THE possibilities of the "kicking coil" type of high frequency apparatus have long been recognized by manufacturers of erator of high frequency currents has not seemed to come in for its due share of popularity among amateur constructors.



Figs. 1 and 2. Wiring diagrams for the kicking coil apparatus

electro-therapeutic outfits but, doubtless owing to the scarcity of published data on the subject, this simple and inexpensive gen-

The kicking coil is an oddity to the uninitiated electrical worker; it is merely a winding of comparatively coarse copper

wire upon a core composed of a bundle of soft iron wires. In this simple coil, which is totally devoid of a secondary, is set up a current of sufficiently high potential to charge a condenser; this high potential is induced at every break of the circuit which permits current to flow through the coil.

Fig. 1 represents a circuit of this nature. The kicking coil *K* is connected at one end of its winding with one side of the supply circuit. The other end of the winding goes to the vibrating armature of an interrupter. From the stationary contact of the interrupter we trace this circuit of the primary of a Tesla or Oudin coil and thence back to the source of supply. A condenser is connected across the break and the primary of the oscillation transformer.

As the current flowing through the coil is interrupted, a high potential surge is set up. This current enters the condenser which discharges its load through the inductance and across the interrupter contacts as soon as the latter close up sufficiently for the charge to leap this small air gap.

By making suitable adjustments of condenser and the ratio between the turns in primary and secondary of the oscillation transformer, a high frequency current of practically any desired frequency and voltage may be obtained, within the limits of the outfit's capacity.

The greatest merit of this apparatus is its ability to operate on either alternating or direct current circuits with merely a slight change in the number of turns in the winding. While it is an undisputed fact that the "kicker" cannot compare with a transformer outfit on alternating current circuits, still it serves admirably in cases where direct current only is available.

The ideal outfit is, of course, one that will operate with workable satisfaction on both direct and alternating current circuits; the latter to comprise various frequencies found in common use. The design offered herewith incorporates all of these desirable characteristics through the introduction of a variable condenser and an extra kicking coil. The latter is short circuited when the outfit is used on alternating current circuits. Fig. 2 gives a diagram of the connections.

This outfit is capable of doing effective X-ray and general electro-therapeutic work within the inevitable limits of the portable outfit. The spark produced is of good quality and in length it reaches fully 7 in. If the oscillation transformer were to be made larger in diameter, the

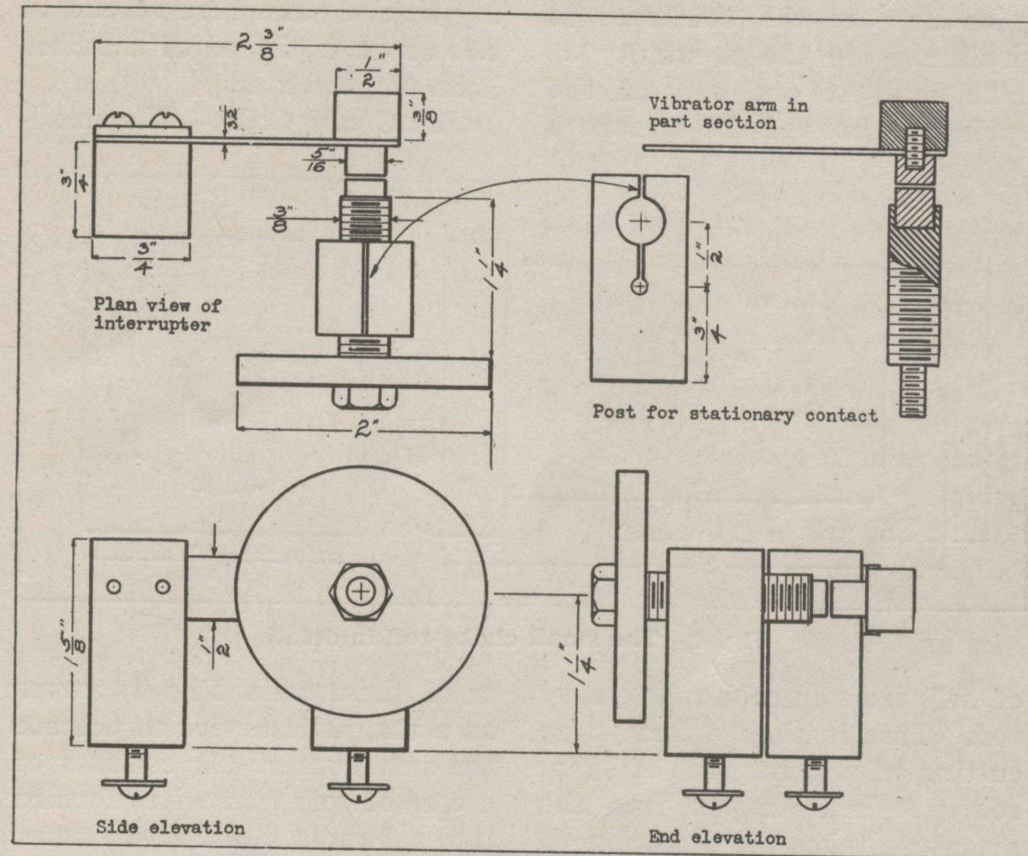


Fig. 3. Details of the vibrating interrupter

spark length could be materially increased without any alteration in the exciting apparatus.

For the lecturer or the experimenter, the outfit is an exceptional one. It is light in weight, inexpensive and simple to build, and, as we have already noted, it is universal as regards current supply.

The Interrupter.—This is the one weak point in the apparatus. While large and elaborate rotary contact breakers are more reliable in operation, they introduce too much weight and cost in an outfit of this nature. The next best is probably a simple vibrating interrupter with massive contacts similar to that shown in Fig. 3.

The posts for the interrupter should be of generous proportions as the drawing indicates. The stock is of ¾ in. square or hexagonal brass rod. The latter is preferable if the worker is possessed of a lathe, as it may be conveniently gripped in the universal chuck for cutting, facing off and drilling.

The spring should be of phos-

phor bronze; the thickness is preferably in the proximity of 1/32 in. At one end of the spring is screwed the armature ing screw. The reverse end of this screw is tipped with a fiber knob of good size.

The Choke Coils.—The small-

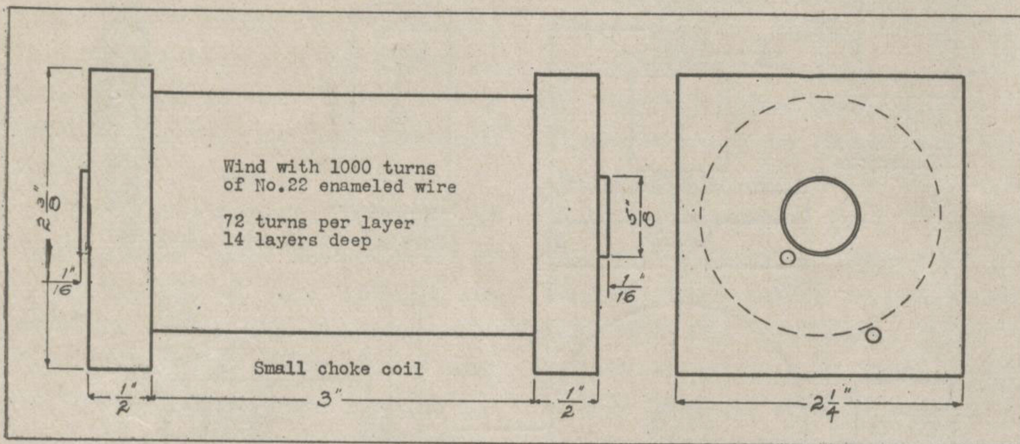


Fig. 4. The small choke coil in detail

of soft iron or cold rolled steel rod. This is simply formed by cutting off a ⅜ in. piece of ½ in. rod. A hole tapped into the armature takes the short length of 8-32 threaded rod that serves to hold the silver contact and armature to the spring.

The contact is cut from a length of 5/16 in. pure silver rod. The little cylinder is to be drilled and tapped to a depth of ⅛ in. to take the 8-32 rod.

The stationary contact is so designed that the tension of one contact against the other may be regulated to a nicety. This is effected through the medium of a fine thread on the adjusting screw which is of ⅜ in. diameter brass rod. The silver contact cylinder is driven into a hole drilled in the end of the adjust-

er of these coils, Fig. 4, serves as a magnetic device to actuate the interrupter. It consists of a core of soft iron wires formed into a bundle ⅝ in. in diameter and 4 in. long, covered with several layers of empire cloth; over this is a winding of 1000 turns of No. 22 D. S. C. or enameled wire wound 72 turns per layer and 14 layers deep. A turn of empire cloth is interspersed between each two layers of wire.

The core is supported between heads of fiber that fit closely over the bundle of iron wires. A good construction is to form a spool of fiber tubing with square fiber heads forcing the core wires into the tube after the winding is completed. As the drawing shows, the layers of

wire do not come quite out to the edge of the layer of insulating cloth; this affords ample protection to the end turns which are subjected to maximum potentials.

The larger of the coils is shown in detail in Fig. 5. The core is 6¾ in. long and ⅞ in. in diameter. The winding is of No. 20 D. C. C. wire wound two in parallel. Each layer comprises 84 double turns and there are 14 layers in all. The same rules as to insulation apply as in the case of the small coil.

The Condenser.—This is of the glass plate variety in the present design. If the builder cares to invest in mica plates of the same size, he will effect a material saving in space and weight.

The glass to be used is of the variety known as "lantern slide cover glass." As the name implies, the glass is used to cover the photographic positive in a lantern slide. The cover glasses are thin and perfectly free from bubbles and the usual defects. They may be purchased from almost any photographic dealer and the standard size is 3 x 4 in.

For the condenser at its maximum capacity, 200 plates of glass will be required. While this large capacity is not always in use, still it is essential for certain classes of work and it should therefore be provided.

The conductor for the condenser is heavy tin foil. This comes in sheets 6½ x 8½ in. and 27 sheets weigh a pound. For our condenser, 200 pieces are to be cut 3¼ x 4¼ in. and for this operation a photo trimmer is well adapted; lacking this, the foil may be placed on a large sheet of glass and cut with a sharp knife.

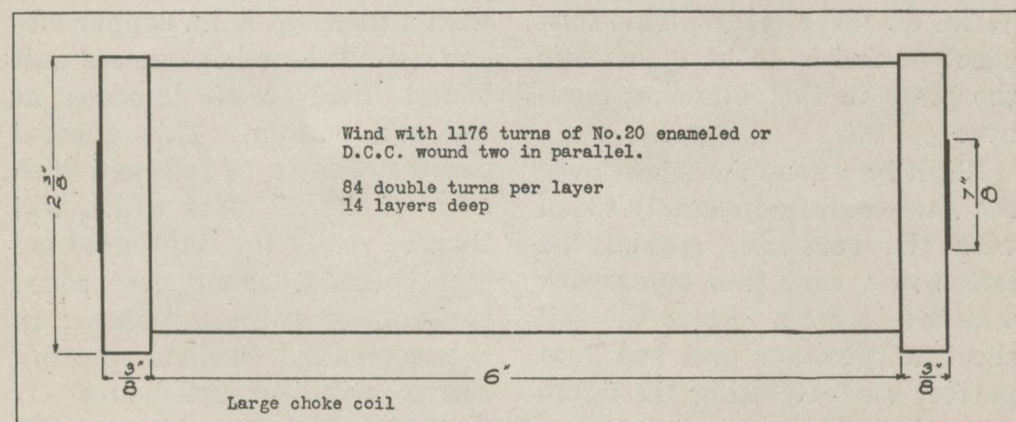


Fig. 5. The large choke coil in detail

The condenser is to be assembled into 20 units of ten plates each. This makes for convenience of adjustment. Each little unit will have a capacity of approximately 0.005 mfd. and the entire condenser therefore reaches 0.1 mfd.

When the assembly is started the builder should provide himself with a small gas or spirit lamp, a lump of beeswax, and a tuft of cotton wrapped in a piece of soft cloth. These accessories on a work table with the clean glasses and sheets of tin foil will enable the worker to proceed.

With reference to Fig. 6 the first plate of each unit is to have its foil sheet projecting to the left. This leaves a margin of ⅜ in. on three sides. This first sheet of foil is to be secured to the plate in the following manner:

Slightly warm the glass over the flame and immediately touch with the beeswax; spread the latter in a very thin layer with a tuft of cotton. Place the foil sheet in position and rub into perfect contact, using the dauber, and working outward with a circular motion.

When this first sheet has been secured to the glass, the latter may be placed on the table with the foil underneath and projecting to the left. A touch of the wax to the upper side of the plate and the second foil sheet may be laid on; this one is to project to the *right* with a margin of ⅜ in. on top, bottom and left side. Next comes a piece of warm glass with its drop of wax; then the third sheet of foil which projects to the *left* the same as sheet No. 1. On this is the third plate of glass, fourth sheet of foil, and so on until 10 sheets of foil and 10 plates of glass have been assembled as shown in Fig. 6.

The object of the drop of wax is merely to insure that the glass and foil sheets will maintain their relative positions during assembly. The unit is now to be "backed up" on either side with a piece of cardboard. The projecting lugs are rolled up with a piece of ⅛ in. copper ribbon enfolded, and the entire unit bound firmly with linotape at top and bottom. This general procedure is to be followed with each of the 20 units which will then be ready for impregnation.

In a double boiler, melt equal parts of beeswax and rosin; in this compound suspend the condenser units for two hours. If the wax has been kept sufficiently hot the interstices between the glass plates will be completely filled and each unit will form a homogeneous mass that is both electrically and mechancially sound on cooling.

The Oscillation Transformer.

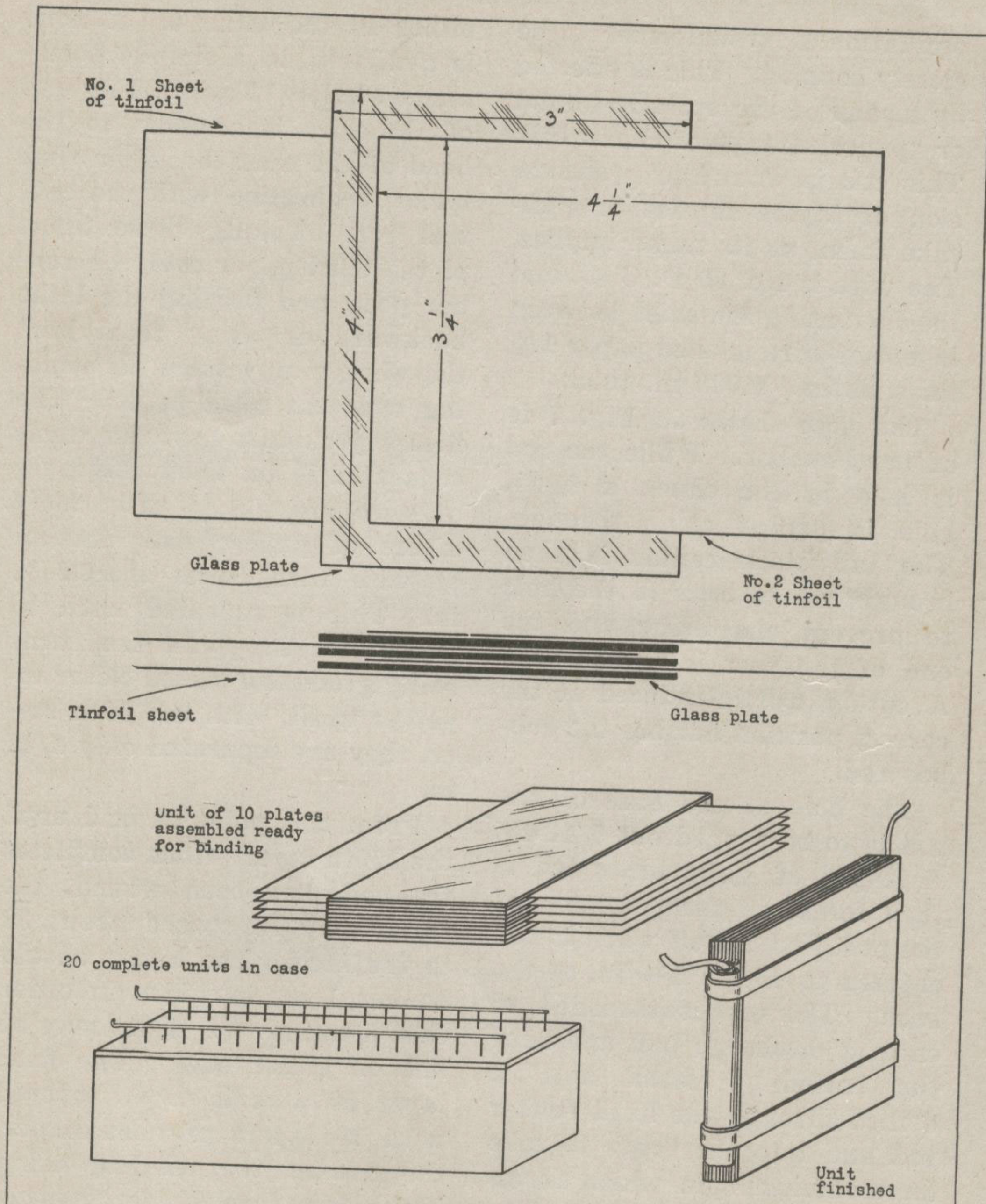


Fig. 6. Details of the condenser

—This may be either of the Oudin or the Tesla type. For the sake of simplicity, the former is preferable. In order that the fullest benefit may be derived from the exciting apparatus it is essential that the primary and secondary of the

oscillation transformer be closely coupled. This is effected by means of the spirally-wound or "pancake" type of Oudin coil. This coil is wound in a succession of layers in flat or pancake form, as its name implies. The wire is No. 30 D. C. C. and the insulating material between layers of wire is oiled paper 1½ in. wide and 0.003 in. thick.

The post shown in Fig. 7 is of hard rubber. While the rod is held in the chuck a ¼-in. hole is drilled clear through. The tail stock center is then brought up to bear in the hole to prevent chattering and the end of the post is finished off. A cut-off tool introduced at the correct position finishes the rubber rod.

The hole at the base of the rod is to be tapped out 5/16-18. A length of ¼-in. brass rod is then forced in from the top of the post and cut off when it has entered to within 1½ in. of the base. The top is threaded to enter a discharge ball and near the bottom a small hole is drilled through the hard rubber rod and into the brass to take an escutcheon pin which forms a means of connection. The rubber post is then to be screwed onto an arbor threaded 5/16-18 with a large disc of metal or wood between. Upon this rig, the pancake coil is to be wound.

The winding may be done either in the lathe or, if none is available, in a simple, home-made winder. The starting end of the wire is soldered to the head of the escutcheon pin that makes connection with the central rod. Taking three turns of the oiled paper over the rubber post, and turning the lathe backward or away from him, the worker may start the winding over the oiled paper. The first layer must have its turns separated ⅛ in. Over this layer of wire are placed three more layers of paper; then another of wire with turns spaced ⅛ in. This is repeated until 50 layers are in place, the turns being gradually placed closer together until, with the 50th layer, they are separated only 1/32 in.

From this point on and until the 150th layer, which completes the coil, has been wound, the turns may be spaced about 32 to the inch. The layers should be but 1 in. in width in order that a margin of ¼ in. may be left on either edge. The final layer of wire is to be covered with 10 layers of oiled paper, the end of the winding being brought out ready for connection with the primary.

The primary consists of 10 turns of copper ribbon, 1 in. wide, wound spirally around the secondary pancake. Between the turns of the primary is a

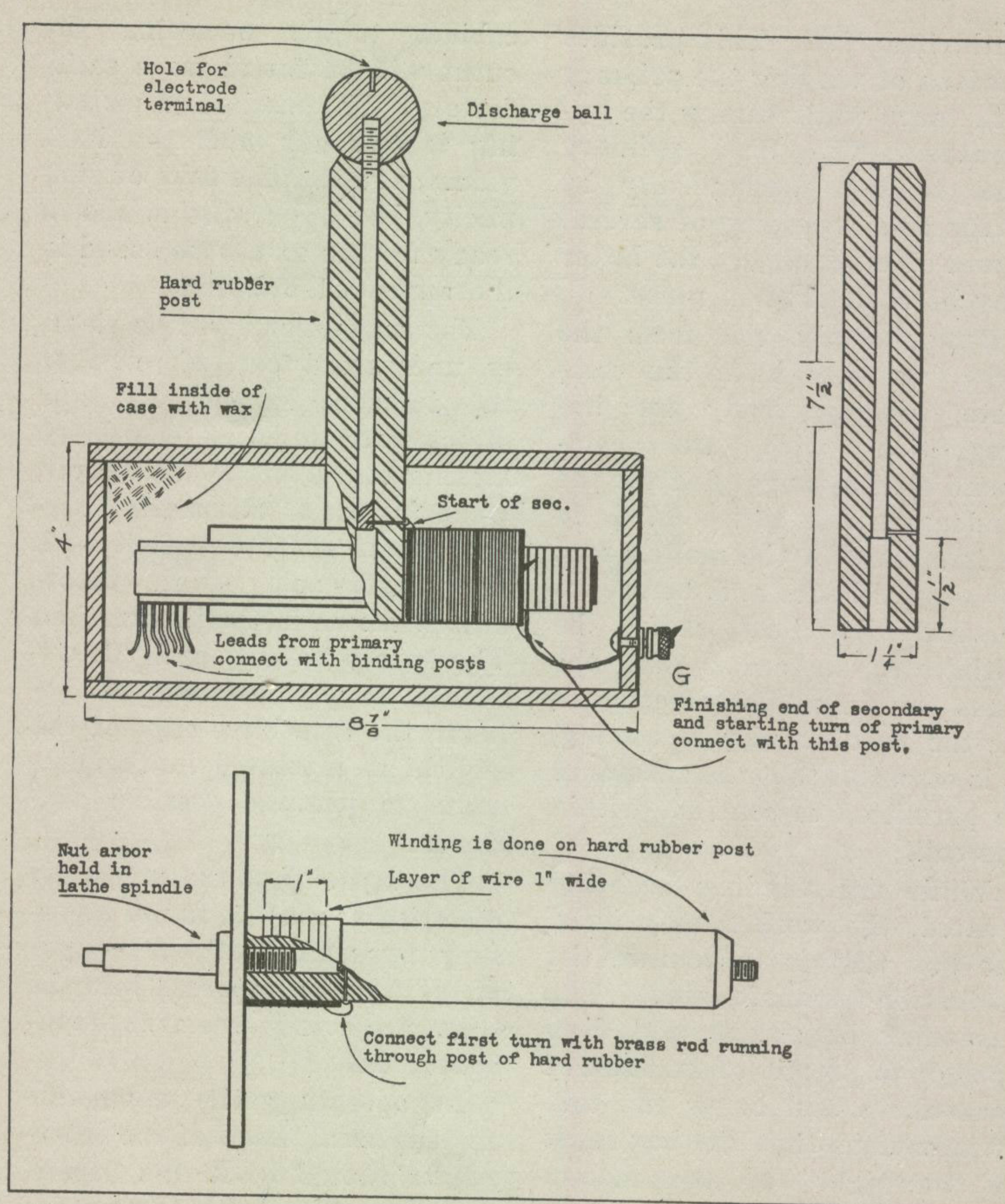


Fig. 7. Details of the oscillation transformer

strip of corrugated board such as is used for packing purposes. The finishing end of the secondary is soldered to the starting end of the primary and at this point a length of flexible lamp cord connects to the junction of the two. The ten primary turns are then wound and a tap of lamp cord taken from the under edge of each of the turns from the third to the

tenth, inclusive. This provides a means of varying the primary inductance while tuning the apparatus. The final primary turn is held mechanically by means of a wrapping of several layers of oiled paper; the latter may be shellacked in place.

Removing the coil from the lathe, we now have the complete winding ready for impregnation with the compound already suggested for the condenser. The entire coil is to be immersed in the molten wax for several hours and, before its removal, the heat should be withdrawn in order that the mass may partially congeal. As the wax shrinks on cooling, it is essential that the substance be permitted to contract within the coil.

While the winding is being treated, the worker may build the box that is to contain the oscillation transformer. The case may be square and deep enough to permit of an inch of wax above and below the coil. It is obvious that the box must be wax-tight for the molten compound is to be poured into this container.

Assembly.—For experimental purposes, the component parts of the apparatus may well be mounted upon a common base board. For portable purposes, such as upon the lecture platform, or with the physician, a cabinet totally enclosing the outfit will be found more satisfactory. The method of mounting is optional with the individual, and, for the sake of simplicity, the apparatus is shown ready for use on a base board in the appended drawing.

The connections will be clearly understood on reference to the diagram in Fig. 2. For direct current work the large kicking coil is left in the circuit, while for use on alternating currents it is short circuited with the single-pole, single-throw switch shown in the illustration. The letters "A. C." and "D. C." should be plainly stamped beneath the respective clips of the switch as indicated in the diagram to prevent possible confusion.

The capacity of the condenser is varied as may be found necessary by means of the copper strips which are forced into the clips projecting from the condenser case.

In operating the apparatus the adjusting knob of the interrupter should be in the "open" position. Turn the current on and screw the contact in gradually. As soon as contact is made the interrupter will begin to vibrate and a sputtering spark will form at the break of contact. The operation should start with about half of the condenser capacity thrown in and

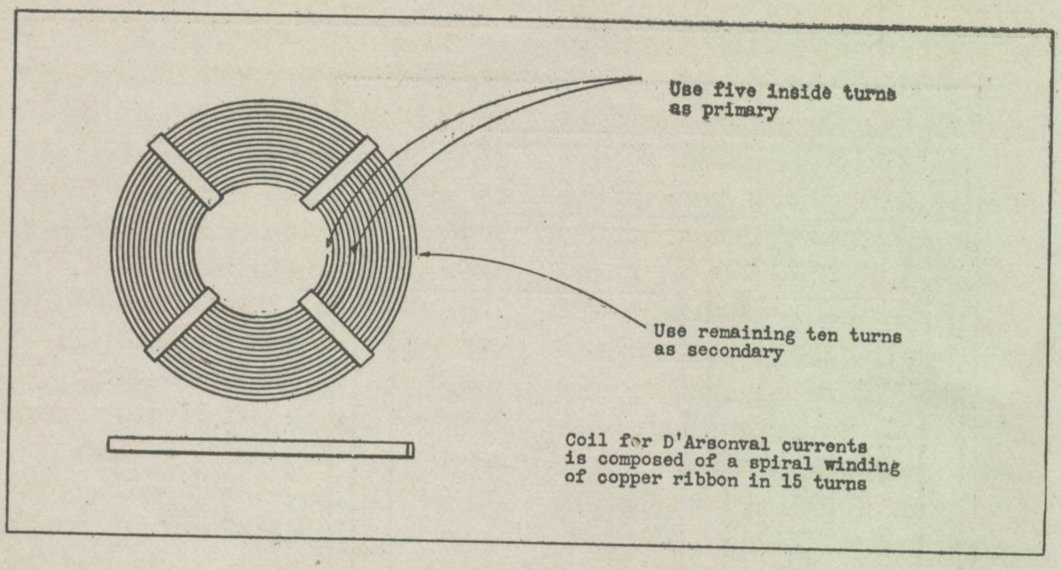


Fig. 9. Coil for the production of D'Arsonval currents

turn from the other. The kicking coil current is sent through the inside turns, say up to four or five, and the D'Arsonval current for the couch is taken from the remaining turns. The diagram, Fig. 9, makes this perfectly clear. The coil may be sealed up in a flat wooden case with taps brought from the respective turns of copper ribbon to binding posts on the outside.

MEETING OF THE RADIO CLUB OF AMERICA

A REPRESENTATIVE gathering of the members of the Radio Club of America, together with many visitors who took advantage of the courteous invitation extended by the Club, were given a genuine treat at the meeting held on the evening of February 18th, in Room 304 of the Engineering Building of Columbia University in New York City. Professor J. Zenneck, Technical Adviser to the Telefunken Company, and a radio expert who has been much in the eye and mind of the engineering fraternity of late, delivered a most interesting and instructive paper which was heralded on the program of the evening as a discussion of "Some Problems Encountered in Radio Engineering" but which subsequently proved to be a remarkably clear and comprehensive exposition of that will-o'-

the ground, which in this case is the keel of the submarine. A polarized relay is connected across the coherer with a single flashlight battery cell in series. The contacts of the relay complete the circuit through bell and solenoid with current taken from the main storage battery, which furnishes current for the driving motor.

Judging from the amount of time the EVERYDAY MECHANIC'S experimenters consumed in covering the ground in this article it is felt that the average reader will have a "fist-full" if he gets this far by the time the next issue of the magazine is off the press. The remainder of the interior mechanism will accordingly be held over for the following instalment. Just as a little appetizer, however, we may point out how nicely the controller fits inside the hull of the submersible—see Fig. 8. Now you see why the "steps" were left inside.

(*Continued in March*)

HOW TO BUILD A 100-WATT RADIO SPARK COIL

By the Laboratory Staff

THE practice of rating radio coils in spark length is much to be deplored. This rating has no significance in itself, as the effectiveness of the coil for radio or high frequency work does not depend upon the spark length, but upon the proportions and design of core, primary and secondary.

Through the use of a suitable interrupter, this coil may be operated at 10 volts and 10 amperes continuously. The secondary winding is of comparatively low resistance, thus it is well adapted to the purpose of charging condensers.

Core and Primary.—The core of this coil is a bundle of soft iron wires tightly compressed into a cylinder 12 in.

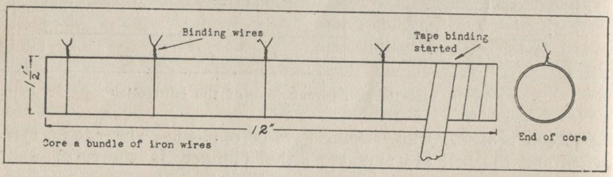


Fig. 1. The core with tape binding started

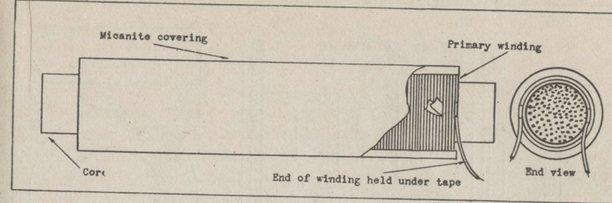


Fig. 2. The core and primary

long and 1½ in. in diameter. The core wire can be purchased ready cut and perfectly straight so that its formation into a cylinder is a simple matter. Given the necessary amount of straight iron wires, the builder grasps the bundle with both hands and with a twisting motion forms the wire into a compact cylinder. A piece of wire is then wound around the center of the core and twisted. Another is added at each end. The twisting operation is then continued, taking up the slack in the binding wires by twisting the ends with a pair of pliers. Soon the bundle will be perfectly straight and hard.

Starting at one end, the binding wires may be removed and a winding of silk ribbon started spirally over the core. The silk is tough and strong, and the worker will be enabled to preserve the solidity of his bundle as he removes the binding wires and replaces them with the silk wrapping. When the entire core is covered the final turn of ribbon may be held with shellac and a few turns of thread taken over the end to insure permanency. The whole core, with its wrapping of ribbon, is then to be suspended in a trough filled with thin shellac. A submersion of an hour will have served largely to fill the interstices between wires and to soak the ribbon thoroughly. The core is then hung up to drain and dry. The latter operation will take the best part of 24 hours. When the shellac is hard the core will be almost as solid as if it were of one piece of iron; it is then ready for winding.

The primary is in two layers. The end of a spool of No. 14 D.C.C. magnet wire is placed under a loop of the silk ribbon on the core and the winding started by turning the core with both hands. The second turn of wire grips the ribbon loop and thus secures the starting turn. The first turn should start at a

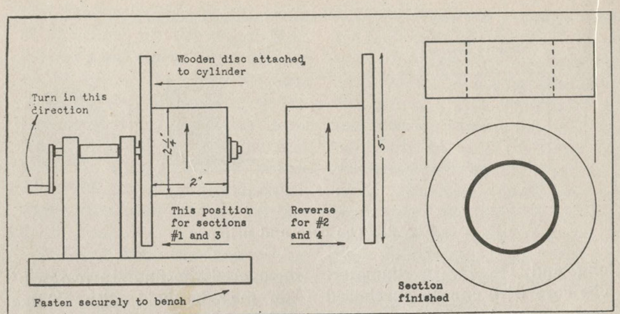


Fig. 3. Winding apparatus for secondary sections

distance of 1 in. from the end of the core and the first layer ends at this distance from the other end. The second layer of wire is wound upon the first, with a layer of empire cloth between. The finishing end of the primary winding is secured with a loop of ribbon, the ends of the loop being pulled tight after the ribbon has been covered by the last three or four turns of the winding. The entire primary is then to be wound with silk ribbon in exactly the same manner as the core and the end where the leads come out should be wound with a number of turns of strong thread to prevent the possibility of the starting and finishing turns coming loose. The entire core and primary is now to be immersed in a compound of equal parts of beeswax and resin, melted in a double boiler to prevent scorching. An immersion of an hour or two will suffice, when the coil may be removed to drain and cool.

Insulation.—When the primary has cooled it may be covered with four layers of micanite sheeting. This substance is built-up mica made into a flexible sheeting about 1/16 in. thick. Very thick shellac is liberally applied as the wrapping proceeds, and when the final turn of the micanite is taken over the primary, the whole cylinder should be temporarily wrapped with tape until the shellac dries out thoroughly. When this is at last accomplished the structure is to be placed in an oven until slightly warm, after which it is stood on end with the lower opening filled and the beeswax-rosin compound poured into the space

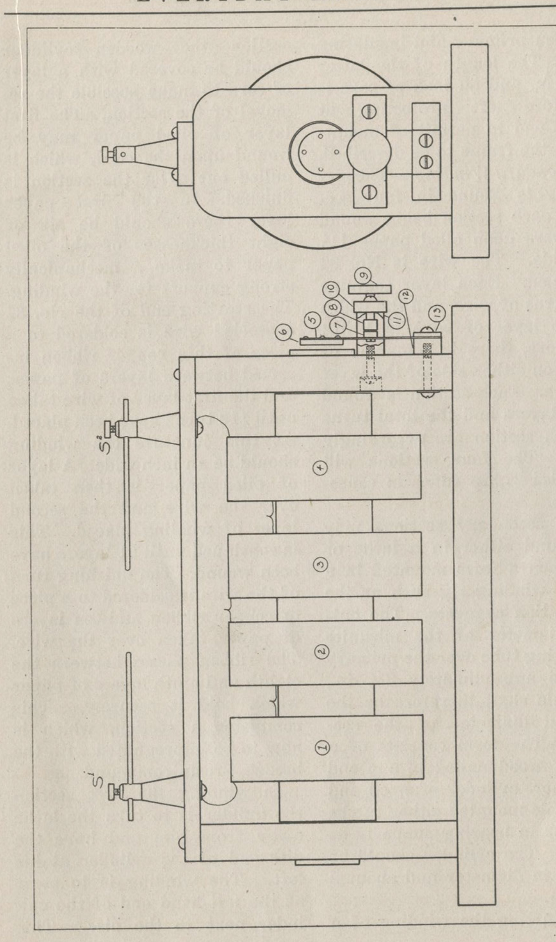


Fig. 4. The induction coil complete

between primary and insulating tube. The length of the latter is 10 in. and an inch of core is therefore left projecting at either end to permit of mounting in the frame to be described.

Secondary Winding.—The secondary is wound in four sections, each section being wound in layers upon oiled paper 1½ in. wide. The wire is No. 32 enameled. Each layer contains 112 turns of wire, and the width of the layer of wire is 1 in.; therefore, there is a margin of ¼ in. on either side of the layer of wire. Each section is wound in 61 layers and the total turns to each section are accordingly 6832. The four sections will comprise 27,328 turns in consequence.

The secondary sections may be wound either in a lathe or else upon a form mounted in a simple winding rig such as the illustration suggests. The outside diameter of the micanite insulating tube over the primary will be approximately 2¼ in., and this shall therefore be the internal diameter of the sections. The form consists of a disc of wood nailed to one end of a short cylinder of wood and the whole mounted either in the lathe or in bearing supports as shown. The cylinder should be 2¼ in. in diameter and about 2 in. long.

In starting the winding of a section the wooden cylinder should be covered with a layer of cord to make possible the removal of the section. The first layer of oiled paper may be wound upon the cord, which is pulled out after the section is finished. In the first paper layer there should be six or eight thicknesses of the oiled paper to make a mechanically strong support for the winding. The starting end of the No. 32 enameled wire is soldered to a piece of thin copper ribbon inserted between layers of paper, and the first layer of wire taken until 112 turns have been placed. At this juncture the winding should be an inch wide. A layer of oiled paper is then taken over the wire and the second layer of winding placed. This is continued until 61 layers have been wound. The finishing turn of the wire is soldered to a piece of copper ribbon and ten layers of paper taken over the wire. The ribbon passes between the eighth and ninth layers of paper which hold it securely. This completes a section, which is now to be impregnated with the beeswax-rosin compound.

In winding the first section the builder is to turn the lathe away from him and have the disc end of the cylinder at his left. The winding is to start at the left-hand end of the cylinder next to the disc. This

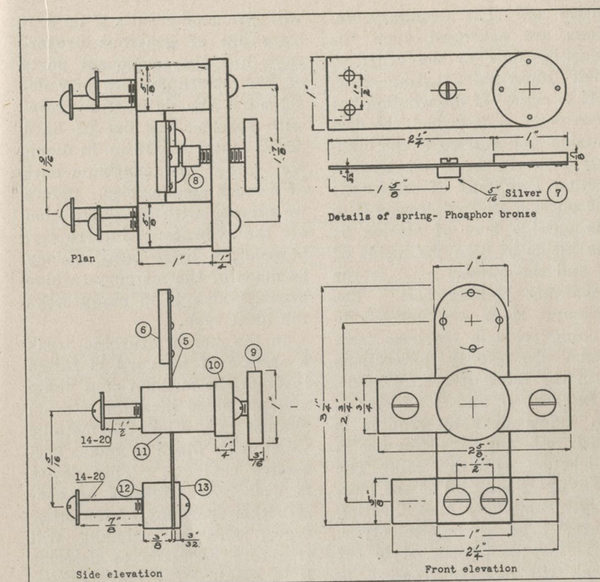


Fig. 5. Details of the interrupter

procedure is also to be followed with one more section. When these two sections are wound they should be numbered 1 and 3. The winding rig is then to be reversed so that the disc-end of the cylinder is at the *right.* Starting the winding next to the disc, as before, and turning in the same direction, *i.e.,* away from the operator, the section under construction will be wound in the opposite direction from the two predecessors. This section is to be numbered 2, and its companion No. 4 is wound in the same way. The reason for this will be seen when the assembly starts.

Assembly.—The frame of the coil is well shown in Fig. 4. The ends of the core fit into holes in upright pieces of wood which form the supports for the

entire coil. The secondary sections are arranged upon the micanite tube in the order of their numbers, starting from left to right. If the winding has been done as described, the first outside lead will go to the binding post, *A*, the inside lead of section 1 to that of section 2; the outside lead of section 2 to the outside lead of section 3; the inside of 3 to the inside of 4, and the outside of 4 to the remaining binding post. The primary leads are carried to binding posts in the base from which the proper connections with the interrupter are made.

Interrupter and Condenser.—An independent interrupter is much to be preferred for use in connection with this coil. The interrupter may be of the mercury-turbine type, the vibrating contact type, or the electrolytic. The last-mentioned style of break will give the greatest results if the interrupter is properly designed and built; if the worker does not care to go to the trouble of making this rather delicate device, the construction of which involves some rather good glass-working, he may purchase the interrupter outright for $2.25. This price would scarcely cover the cost of the materials and the workmanship on the break if the amateur worker were to build one.

The vibrating type of break will give good results if its contacts are of generous proportions and the component parts of the interrupter properly designed. The data given herewith specifies the use of hard silver contacts 5/16 in. in diameter rather than platinum ones of a much smaller size. Before we proceed with the description of the vibrating interrupter, however, a brief mention may be made of the mercury-turbine break, which is in many ways the ideal type.

In the mercury-turbine break a stream of mercury is raised through the medium of a pump and projected in a fine stream against a series of metallic vanes with which it makes successive contacts. This device is even more difficult of construction than any of the other types, and no attempt will therefore be made to describe it in detail. The mercury-turbine interrupter costs in the proximity of $9.00, and it requires a small electric motor for its operation. It may be used on practically any voltage from six to 110.

The relation of the vibrating interrupter to the rest of the coil is shown in Fig. 4, while the details of the interrupter are given in Fig. 5. Using the reference numbers in the drawing, 5 is a spring of phosphor bronze, 3¼ in. long, 1 in. wide and ap-

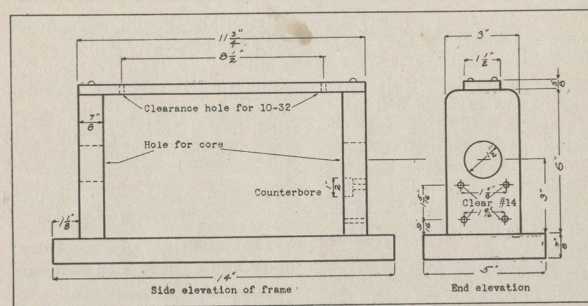


Fig. 6. Details of the frame-work

proximately 1/32 in. thick. To the end of this spring is secured the armature, 6, of soft iron, by means of four small screws. This armature may be turned from ⅛-in. soft iron bar or it may be cut from the end of a 1-in. rod of the same material. The contact, 7, is cut from a piece of 5/16-in. silver rod, drilled and tapped for the small screw that secures it to the spring in the position shown. The stationary contact, 8, is made of the same material, and it is carried on the end of the 14-20 milled-head screw, 9, which is threaded into the stud of silver. The adjusting screw, 9, is carried by a cross arm of heavy brass bar, 10, which, in turn, is supported by pillars of brass, 11, at either end. The vibrating spring, 5, is supported at its lower end upon a bar of brass, 12, to which it is secured with screws passing through a washer plate. This construction is essential in order that the spring may have a definite point or edge from which to vibrate.

The condenser to be shunted across the interrupter should be adjustable. The builder is strongly advised to purchase this condenser outright. The task of making up a condenser of tinfoil and paraffined paper is a discouraging one, and the manufactured article can be purchased so cheaply that the amateur builder is not justified in making one. The standard telephone condenser of 1 mfd. capacity is approximately correct in capacity, and if two more sections of .5 mfd. each are added the necessary range of adjustment is obtained.

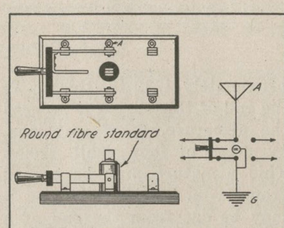
If the builder wishes to build

his own condenser he may purchase 250 sheets of heavy paraffined paper such as is used to wrap candies in. This paper may be cut to form 500 sheets of paper 8 x 10 in. in size. The tinfoil should be thin in order that cost and weight may not be inordinate and it is to be cut into 6 x 8-in. pieces. These tinfoil sheets, with strips laid on alternately for lugs, are placed between the waxed paper sheets in piles of 100 sheets each. The condenser will therefore comprise five units of 100 sheets to the unit. The specifications given are for a condenser of large proportions, but in the author's experience the average amateur builder is not equipped with the presses necessary to compress the units to the extent where their capacity is large for a given size of sheet. The only device of this kind that is within the reach of the experimenter is a letter press, and this implement gives but a small fraction of the pressure used by the manufacturer of the standard condenser.

High-tension Condensers.—The condenser for connection across the secondary of the induction coil may be made by coating both sides of an 8 x 10 photographic negative with tinfoil in sheets 6 x 8 in. in size. Probably but two or three of these condenser plates will be necessary if they are connected in multiple. For high-frequency coils the condenser will be somewhat larger than for general radio work, but the experimenter will not need to make more than half a dozen of the 8 x 10 plates to insure ample capacity.

Combined Aerial and Ground Switch

The addition of a central blade and an insulated post carrying an extra set of clips converts an ordinary double pole, double throw knife switch into a combined aerial and ground switch. As the illustration shows, the switch is thrown to the left for receiving and the right for sending or *vice versa.* When it is in the neutral or "open" position, the extra blade makes contact with the clips on the central post and the aerial is thus connected with the ground. This will dissipate any charge that may collect on the antenna while the set is not being used.



The combination switch

CONSTRUCTION OF A TRANSATLANTIC RECEIVING SET

By Louis Gerard Pacent
Member Institute of Radio Engineers

Part I.—The Long Wave Receiving Transformer

Editor's Note: Mr. Pacent is in charge of the Radio Department of the Manhattan Electrical Supply Company of New York City and needs no introduction to the host of keen radio enthusiasts in the vicinity. His present offering is the first of a series of constructive articles on modern radio receiving apparatus.

THE work of Mr. E. H. Armstrong of Columbia University has proved to Radio Engineers that the audion produces oscillating currents in the wing circuit rather than a unidirectional current. By tuning the circuit so that the amplitude of the oscillations was greatly increased, they were found to react upon the grid and regenerate a larger current. The response in the telephone receivers was amplified accordingly. Operators who use receivers employing these circuits, with constants properly calculated, have little difficulty in picking up

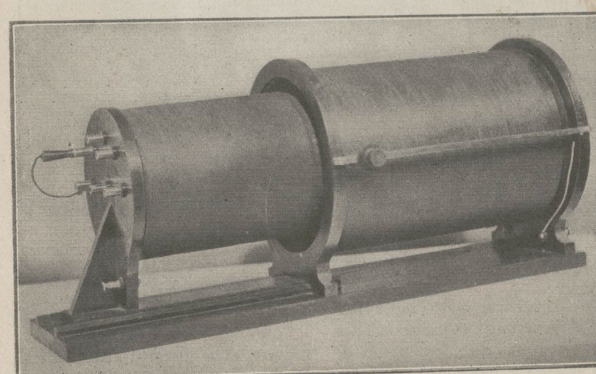


Fig. 1. The long wave receiving transformer as it appears when finished

RADIO TELEGRAPHY —AND— TELEPHONY

CONSTRUCTION OF A MODEL SUBMARINE WITH WIRELESS CONTROL

PART II. PHOTOGRAPHS OF THE HULL AND CONSTRUCTION OF THE CONTROLLER

BY THE LABORATORY STAFF

A FEW photographs of the hull of the model in various stages of completion are reproduced in the present article. These photographs were taken in the laboratory while the hull of the EVERYDAY MECHANICS model was taking shape.

Fig. 1 shows the seven planks roughly cut to shape and nailed together temporarily while the hull is being roughed out with the draw-knife. In the picture, the bow is practically finished, while the stern is entirely in the rough. Fig. 2 shows the hull after it has been brought roughly to shape with the draw-knife. The cracks between the planks will be noticed in the illustration, showing that the boards have not been permanently nailed together at this stage. The lines of the hull are entirely developed, however, even at this early period.

As described in the preceding instalment, the planks are to be taken apart and the center portions cut out with a compass saw. This portion of the work was found to be laborious in the extreme, and more than once the workers wished that they had access to a bandsaw. After one full day's work, the two constructors produced the hull completely hollowed out, formed, and ready to coat with white lead and nail together. This task required another full day, at the end of which the workers had produced the result shown in Figs. 3 and 4, which show respectively the hull with No. 7 plank removed and the hull complete. In the latter view the reader will note that the top plank has not been secured permanently. As the preceding chapter stated, this last plank is not to be nailed until the greater part of the machinery has been installed.

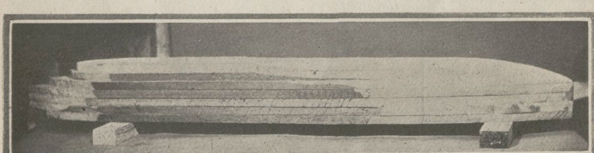


Fig. 1. The hull planks nailed together and bow partly formed

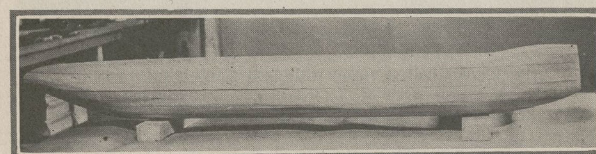


Fig. 2. The hull after it has been brought roughly to shape with the draw-knife

The Control Device.—This feature of the model will be described at some length partly because it is the most difficult of all to build, but more especially because it is the very heart of the craft—the nerve center from which every movement of the little submersible is directed.

The principle of the device is easily understood on reference to Fig. 5, which shows a photograph of the controller from directly above. To the left is seen a row of contact fingers or brushes of phosphor bronze. These are rigidly mounted upon a wooden support which is more

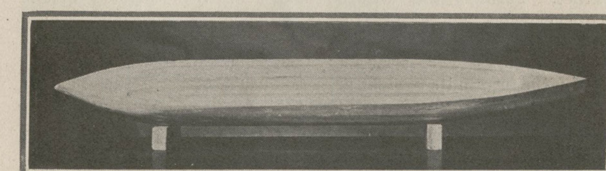


Fig. 3. The hull finished, showing how inside is hollowed out

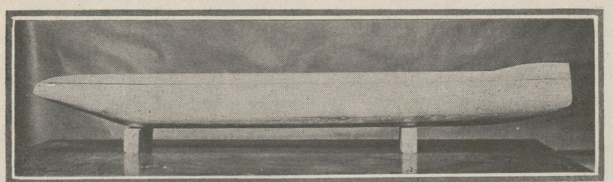


Fig. 4. The hull complete with deck plank laid in place

clearly shown in Figs. 6 and 7. Underneath these contact fingers is located a wooden cylinder, bearing a series of contact studs all connected with a central shaft. This cylinder rotates freely upon a shaft supported in simple bearings made of brass strip.

On one end of the cylinder shaft is soldered a small rachet removed from an old clockwork. Rotating freely upon the shaft is a projecting arm which carries a pawl that engages the rachet. Perhaps this will be more clearly understood from the drawing, Fig. 9. A coiled spring of brass wire serves to return the arm to its upright position and a stop passing through the brush support limits its travel in the upward direction.

Connected with the arm is the plunger of a small solenoid made by winding eight layers of No. 24 enameled magnet wire upon a simple spool of brass tubing with metallic heads soldered on. The dimensions are given in Fig. 9. The plunger in our model was made from a heavy nail filed to the desired shape and cut off with a hacksaw. The plunger is a free sliding fit inside the tubing of the solenoid. Lubrication is vaseline or petroleum jelly if no hard grease is at hand. The thick lubricant serves to retard slightly the lightning-like movement of the plunger.

The solenoid is linked to the base as shown in the drawing, and beneath the pivoted joint is a spring of phosphor bronze sheet. This is quite essential, as the weight of the solenoid bears so heavily upon the plunger that it will not operate until its weight is relieved by the spring as shown.

It is obvious now that if a current be sent through the solenoid, the plunger will be sucked into the coil and the cylinder turned as the pawl engages the ratchet. The downward movement of the arm is

limited by the screw in the base. The extent of the movement will depend upon the diameter of the rachet, the number of its teeth, the distance apart of the contact studs on the cylinder, etc. In our model, the movement of the plunger is just ¾ in. The diameter of our rachet is 5/16 in., and it has fifteen teeth. The contact studs are spaced ⅝ in. apart on the circumference of the cylinder, and the plunger must make two trips to move the cylinder from one contact to the next.

Each one of the brushes is connected with a different piece of apparatus inside the hull. For instance, with reference to Fig. 5, the top brush may go to the driving motor. The contact here is not a stud but a ring of brass strip that nearly encircles the cylinder. The object of this is to permit the driving motor to run throughout the entire time that the boat is away from shore. Therefore the first two pressures of the key will serve to start the propeller. The craft starts off, running parallel with the shore. Two more pressures of the key at the transmitting station on the shore and the cylinder rotates

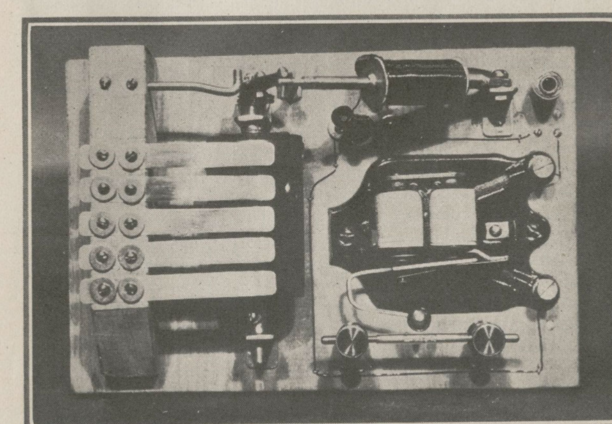


Fig. 5. Photograph looking down upon the controlling device

sufficiently to bring the second contact under brush No. 2. This brush may connect with the steering rudder at the stern. This rudder is operated by means of a solenoid also. The rudder is turned, and the submarine leaves its course parallel with the shore and starts out to the middle of the lake or pond. A third signal releases the stern rudder, and tilts the horizontal or diving planes on the sides of the hull. The craft then settles in the water until the deck is awash. It may travel in this condition until the next signal, which releases the planes and admits compressed air to the torpedo tube. The torpedo is thus fired as the boat returns to the surface; she comes up just in time for her imaginary crew to sight the results of the explosion which may be timed to take place at a distance of from twenty to forty feet from the model.

A fifth pressure of the key disconnects the torpedo tube and sends current through the steering rudder solenoid on the reverse side. The craft slowly turns, running awash or on the surface, and, when she is heading straight for shore a sixth signal releases the rudder, which returns to its normal position. The motor is still running, and the craft is thus carried back to shore. A last pressure of the key and the cylinder returns to its starting point or the "off" position. This stops the driving motor.

The Coherer.—This device is one of the oldest and most severely criticised of all of the many detectors for oscillatory currents known to-day. At the same time, in the hands of our experimenters it has proved to be simpler, and more reliable than any of its rival devices. As for its susceptibility to the influence of electromagnetic waves, the coherer used in our controller has shown itself to be quite as good as many, and superior to some of the later devices.

During the course of their experimental work, the builders found that the orthodox method of using a coherer would not do at all in the present case. The usual directions that accompany one of these instruments when purchased of a dealer will tell the worker to use a very minute quantity of filings in the glass tube, separating the plugs barely a sixteenth of an inch. This may work and probably it has worked for many experimenters, for those directions are invariably given. The writer of this article, however, goes on record as saying that the only results obtained through this procedure in the case of our controller were unsatisfactory,

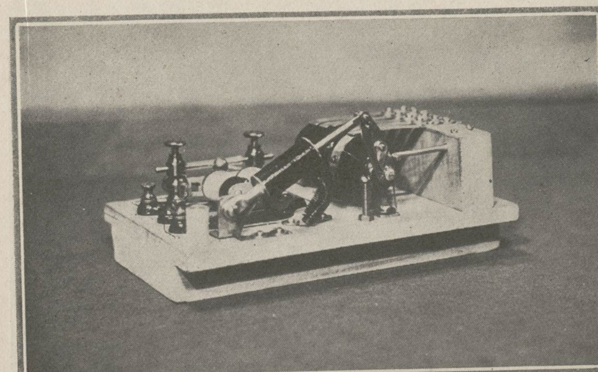


Fig. 6. The control device, showing ratchet, arm, plunger, and solenoid

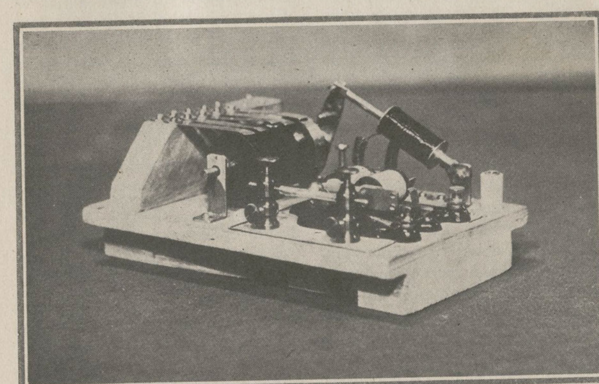


Fig. 7. The controller, showing coherer and contact fingers

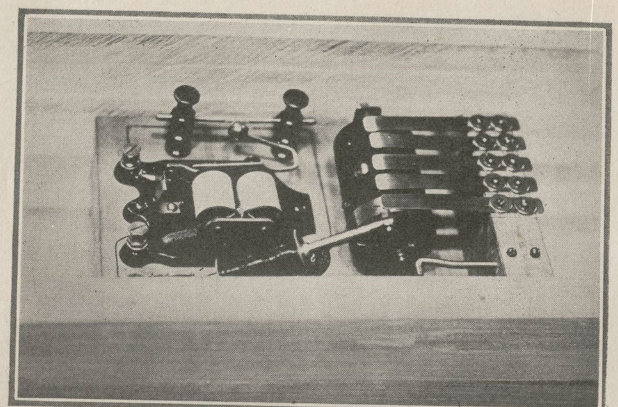


Fig. 8. The controller resting on "steps" within the hull

unreliable, and thoroughly disgusting. The device may have been more sensitive, but we could not discover wherein this quality was to be found. The filings would not de-cohere sharply even when the de-coherer contacts were shunted with a small water shunt. The contraption would work sometimes, and sometimes it declined to do anything when the key was pressed. Then all of a sudden it would take a notion to work frantically even though no signals were passing. Finally, in despair, after having tried out many other forms of detectors without avail, the workers filled the glass coherer tube half full of a mixture of equal parts of silver and nickel filings and separated the plugs a full half inch. From that time on, and with the most indifferent kind of adjustment, the device has *worked*. The mixture has been removed and fresh inserted with no disappointments. The plugs have been removed and handled with the fingers, replaced, and the device operated as well as ever. For two entire days the coherer has been operated at intervals of half an hour without missing a signal and without once repeating or failing to de-cohere. Whether this be the result of a pure accident or whether it is a method well known to other

workers is of no consequence. It works and works well. That is the important point.

The coherer for our model was of the cheapest amateur variety. The device consists of two binding posts of the "double" variety, two short lengths of brass rod with one end of each amalgamated, and a length of glass tubing that fits snugly over the brass rods or plugs.

The de-coherer is merely an electric bell mechanism with the gong removed and the arm cut off while the clapper arm has been bent back to shorten the movement of the clapper and prevent it from breaking the glass tubing. This stunt was introduced after several tubes had been broken. The binding posts and the bell are mounted upon the controller base as shown in Fig. 5. In the upper right hand corner of this picture a small cylinder will be noted. This is a resistance coil consisting of ten layers of No. 34 German silver, single silk covered wire, wound over a 1-in. piece of ¼-in. brass tubing. The solenoid of the controller is placed in series with the resistance bobbin and the two shunted across the binding posts of the bell. This resistance is to prevent too large a current from passing through the bell when current is applied to the solenoid. The latter requires about eight volts to give the necessary "kick" to the plunger, while the bell would be overloaded with such a pressure applied to its terminals. The bell and solenoid together, with the resistance in the bell circuit, draw just two amps. with eight volts applied. The suction on the plunger is powerful and positive.

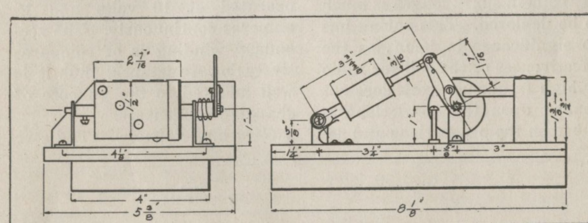


Fig. 9. Details and dimensions of the controller

The coherer circuit is the usual one. From one side of the coherer a wire leads to the aerial; the other side goes to

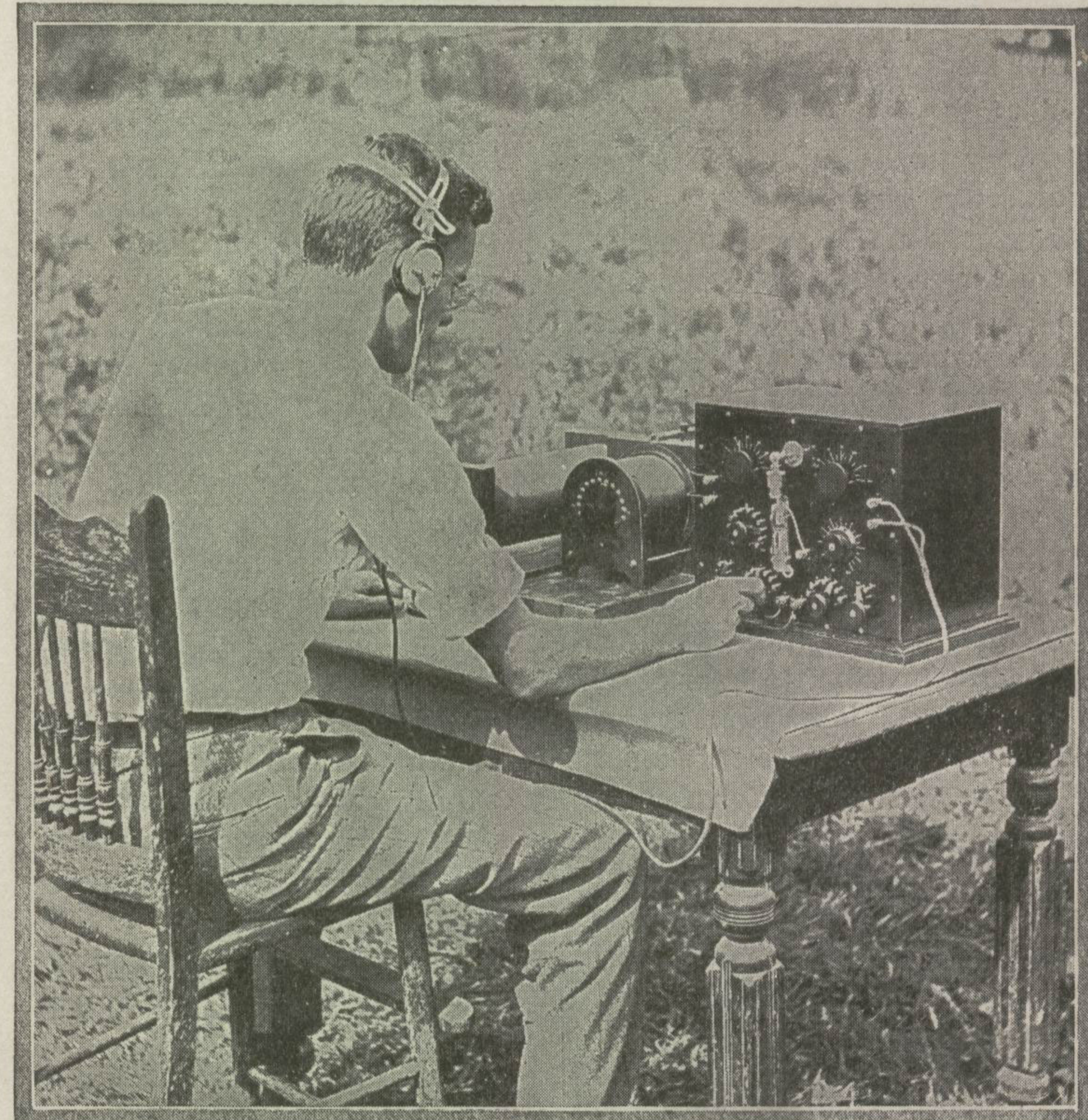
the ground, which in this case is the keel of the submarine. A polarized relay is connected across the coherer with a single flashlight battery cell in series. The contacts of the relay complete the circuit through bell and solenoid with current taken from the main storage battery, which furnishes current for the driving motor.

Judging from the amount of time the EVERYDAY MECHANIC'S experimenters consumed in covering the ground in this article it is felt that the average reader will have a "fist-full" if he gets this far by the time the next issue of the magazine is off the press. The remainder of the interior mechanism will accordingly be held over for the following instalment. Just as a little appetizer, however, we may point out how nicely the controller fits inside the hull of the submersible—see Fig. 8. Now you see why the "steps" were left inside.

(*Continued in March*)

(C) Jeff Behary 2021

and a variable condenser in the immediate audion circuit is ad-



The apparatus completed and in use as a field set at the *Everyday Mechanics Experiment Station*

ground lead. Two thousand ohm justed. It is at this point that

Everyday Mechanics

TRADE MARK REGISTRATION APPLIED FOR

Vol. 2 No. 1 10¢ Oct., 1916

"The Construction of a Super-Sensitive Audion Receptor"

"It Fits Your Pocket"

envelope, offer conclusive proof that there is nothing whatsoever concealed inside it. A playing card is chosen from a deck and, after the suit is called aloud, the card is torn into several small pieces; which are stuffed into the funnel-shaped tube attachment of a conjurer's pistol. The wizard points the gun at the stand and envelope, and fires. Instantly, the playing card, mysteriously restored, is seen inside the envelope; the rays of the strong light clearly silhouette the mysterious presence of the card. The envelope is removed from the stand; an end is torn therefrom, and the playing card is passed for inspection.

The stand is mechanical. A card, the duplicate of the one originally "forced" on the chooser, is concealed in the base. Two small rods, working upon springs, and hidden behind the two posts of the stand, carry the card into view, behind the envelope, at the desired moment. A pin, tied to a thin silk thread, the free end of which is in the hands of an off-stage assistant, enables the magician to regulate the appearance of the card. When the end of the envelope is torn open, the card is really drawn from behind the envelope, rather than from inside of it; this deception, however, is impossible to detect.

Static Machine Contest

(Continued from page 501)

smallest fold of the condenser, and the knife, when being manipulated, should be pressed downward rather than drawn along. On opening the condenser, a number of tinfoil sectors, all cut to the same size, will be found between the waxed papers.

A good and simple collector is illustrated in Fig 4. Here a tube of copper is bent as illustrated, and drilled to admit of the insertion of a number of phonograph needles; flux is then applied, and the whole construction is heated, after which solder is fused around the needles. The optional method is to fill the tube with an easily fusible alloy, bend it while hot, drill the holes, insert the needles, and heat again; the fusible alloy will melt around the needles, holding them in position. Another collector which may easily be built, and is just as serviceable, is indicated in Fig. 5.

A piece of copper screen (fly screen preferred) is soldered across the tines of the fork. Allowing about 1/8" clearance on either side of the plates, cut out a section of the screen; and then pull out some of the wires, as illustrated, to produce teeth of the comb.

One of the simplest methods of making brushes is illustrated in Fig. 6. A .22 rifle cartridge is drilled, a piece of No. 18 or No. 20 B&S gauge wire is passed through the hole; then a tuft of Litz wire is fastened to the copper wire, as shown. Pull the Litz tuft into the cartridge, heat carefully, and pour some solder and flux into the cartridge, then trim the wire ends carefully with a pair of scissors.

An ingenious form of condenser is illustrated in Fig. 7. A Pyrex glass test tube, 1½" in diameter, is dried thoroughly to remove air moisture (do not use lead glass, or common test tubes). A grid cap of a vacuum tube is removed from an old tube so as to leave some of the wire connection.

Fasten this cap in place by filling with sealing wax, heating, and applying to the bottom of the test tube. The wire lead should project from one side. Now, wrap the outside with tinfoil for about two-thirds the height of the test tube, holding it in place with shellac. Slit the bottom of the tinfoil, and fold over. Coat the inside of the test tube with shellac and insert a layer of tinfoil to the same height. Add the cork, a metal rod with ball at end, a short piece of chain attached to metal rod long enough to reach the bottom, and contact with the tinfoil inside, and a piece of chain to cap to reach the "ground."

Another condenser construction, of the flat-plate type, is indicated in Fig. 8. If the plates are 4"x5" in size, or larger, keep the tinfoil sections, made as illustrated, 1" from the edge. The tinfoil is held in place with shellac, and alternate tinfoil sheets are connected together by means of the projecting tabs.

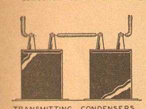


Fig. 13 Transmitting condensers are built to stand higher voltages than those in radio sets. Connecting them like this reduces capacity and also liability to break down.

To make a leather belt for the drive, use the system illustrated in Fig. 9. Cut a slot in a piece of board, insert a razor blade at an angle, and erect a small block of wood behind the razor blade, at a distance equal to the desired thickness of the belt. Cut a piece of leather, circular; then snip a short distance in from the edge, pass the cut in back of the razor blade, and pull. A continuous leather band will result.

Fig. 10 shows the construction of a simple drive mechanism. Two angle-iron shelf brackets are drilled to accommodate the shaft; three pulleys are attached, then one of them is drilled to take the handle and its attachment screw.

Figs. 11 and 12 show how discs can be attached to the shaft of a fan or other motor; the bearing is a simple pivot. Fig. 13 shows how radio transmitting condensers should be connected in series so that the voltage is divided across them, hence there is less danger of the condensers breaking down.

All these suggestions may be incorporated into the construction of your own static machine.

Casting Small Models

(Continued from page 506)

very fine sand will make a satisfactory investment, capable of withstanding heat. Keep this in a tight can, ready for use. A good rubber mixing bowl can be made by cutting the bottom half from the bulb on an old atomizer or bulb syringe, Fig. 7. The advantage of a rubber bowl for mixing plaster will be obvious when you come to clean it.

Mix up enough "investment" material to fill the casting-ring, at a consistency thick enough to pour. If your model has some fine detail, it will be necessary, before placing the casting-ring, to paint the whole surface of the wax with the investment, using a fine camel's-hair brush. Go over it thoroughly, blowing off the superfluous plaster occasionally, and forcing the investment down into the undercuts with the brush. This is a most important stage, and failure to eliminate trapped air-bubbles, or to have the investment adhering evenly over all, will cause a rough unsatisfactory casting to result.

Having painted the pattern, place the casting-ring back in position and pour in the balance of the investment, tapping the side of the ring to jar up the air bubbles. When it is filled, draw a fine file lightly across the top several times. This vibration ensures the removal of all air particles, and settles the investment down into all the crevices of the model. Now put the ring aside to set, which it will do in ten minutes or so. When set, invert the ring in your left hand, and tap the base lightly all around. It will loosen and come away, leaving the end of the sprue-pin sticking out of the investment. If you used wax, you may heat it slightly and peel it away. Then hold the end of the sprue-pin in the Bunsen flame to melt the wax attachment at the other end, and remove it with a slight twist, so as not to mar the plaster. A light pair of pliers is used to seize the pin. You have now the wax model buried in a plaster investment, with a sprue-hole leading to it. The next object is to remove the wax.

Place the iron spider over the Bunsen burner, and put a few pieces of old plaster, coke or broken pottery in it. On this set the ring, inverted—that is, with the sprue-hole down. Apply the heat slowly, gradually increasing it for a period of from 15 minutes to an hour, depending on the size of the ring. The wax will melt and run out of the sprue-hole. Then the ring should be set on the spider with the sprue-hole uppermost, and full heat applied until the ring is dull red, and all traces of carbon disappear from around the hole. It is now ready for the operation of casting.

The dentist's casting machine may cost over a hundred dollars, working on the centrifugal principle, or he may still use the device of his student days, which he created for ten cents. I like the latter, just as well, except that it is not subject to pressure control; and that is a point that need not bother us here at all. Its base can be made of any metal can-like object—the hub-cap of a Ford, a threaded blind-end for piping, a cylinder cut from a pipe, with a base soldered to it. For the larger castings, a cow-bell with the clapper and ring filed away, is very serviceable. Bore two holes through the rim to receive the wire handle, which is curved like a bucket handle, and secured firmly but so loose that it will readily fall to the side of the bucket when at rest. This handle is treaded through a length of dog chain—about eight inches in the smaller buckets—and through the last link a screw is passed and let in to the end of a hardwood handle, taken from some tool, Fig. 4. The chain should swing freely on the screw; as the casting operation is performed by rapidly swinging the bucket about the handle.

(To be concluded in the next issue)

Canoe Sail and Lee Boards

(Continued from page 502)

The plans call for a band of metal about an inch wide to be driven on the top end of the mast and on the ends of the spars. These are to prevent the ends from splitting, and are a protection when the spars are used as tent poles. Long, heavy screw-eyes with small eyes (such as No. 204) are best for the ends of the boom and spar, except that a No. 4, with a larger eye, should be used for the lower end of the spar. (The spar used along the foot of the sail is called the boom.) If preferred, the spars may be made a few inches longer, boring holes through them near the ends by which the corners of the sail can be attached, in-

Wimshurst Machine from Scraps

(Continued from page 500)

which are first removed, come in for use in other parts of the machine. The base is a block of 1" oak, and the posts are mounted on it in the following way; holes slightly larger in diameter than the posts are bored half-way through the wood. Some flowers of sulphur are then melted in a tin over a gas jet, and the liquid is poured into one of the holes. The post is stuck in, squared up, and held until the sulphur cools. Posts mounted in this way are surprisingly firm. (Fig. 3)

To strengthen the middle posts, which carry the bearings of the plate spindles, a hole is drilled through each, about half-way up; and a brass rod from a lead-in tube is pushed through and bent in a semi-circle. The two ends, which are threaded, are then bolted down to the base in the manner shown.

The bearings and collecting combs can be attached to the tops of the posts by tight-fitting screws, which will cut their own threads in the vulcanite. The collecting combs themselves are made from lengths of brass rod bent into a U. A convenient number of small holes are drilled through each arm of the U, and phonograph needles, broken off to a suitable length, are soldered in. The ends of the rods should be carefully rounded; as it is essential in electrostatic machines to have all metal parts smooth and polished, and to avoid all sharp corners. However, since all electric charges are carried on *the surface*, it does not matter whether the parts are hollow or solid.

The combs are then so mounted that the plates can revolve between them without quite touching them. The clearance may be as much as a fifth of an inch without any serious loss of electrical charge.

Eight strips of tinfoil are shellacked at equal distances, on *one side only* of each phonograph record; and a wheel with a setscrew is bolted to the centre to facilitate attachment to the spindles. The records are then mounted to rotate back to back, the foil strips facing the points of the combs. To keep the records apart, a ball-bearing is slipped in between the two spindles; which also makes for smooth running, since the spindles rotate in opposite directions.

On the tops of the brass knobs, to which the combs are attached, the terminals from a lead-in tube are soldered. Two of the brass knobs can then be bent into semi-circles and screwed in to form the "conductor arms." These terminate in two brass balls (between which the sparks are produced), at the top of the machine. It is as well to use smooth rods, to avoid the sharp edges which occur inevitably if they are threaded throughout their length. Brass bedpost knobs are attached, by filling them with metal cement, and then pushing the rods in. Alternatively, large bright ball bearings could be soldered on.

The pulleys must be so chosen that the two plates rotate at the same rate. The brushes are made from short tufts of wire taken from a piece of "flex" electric lighting wire. One brush is soldered to each end of a piece of brass wire about 7" long, and the wire mounted on a spindle bearing, as shown in Fig. 4. (This assures its being well grounded.) The two arms of the wire are so bent as to make an angle of 45 degrees with the vertical, and the brushes adjusted so that they ground a foil on opposite edges of the plate simultaneously. The brushes on the other plate are set at right angles to these, and ground their foils at the same time.

If the whole instrument is brightly polished and perfectly dry, on turning the handle, slowly, a "sizzling" sound will be heard. This is due to internal discharges in the machine, visible as a blue glow, with sparks, if performed in the dark. On turning a little faster, sparks up to ½" in length will jump between the brass knobs at the top of the machine.

If you get no results at the first attempt, see that the brass knobs are not touching, and then rub a vulcanite rod briskly on your sleeve to electrify it. Hold it to *one* of the combs while turning the handle, and the machine will soon charge up and function normally. Sparks produced in this way, without the use of Leyden jars, can be taken on the finger or knuckle without harm or appreciable shock, though the voltage for a half-inch spark in dry air is 30,000!

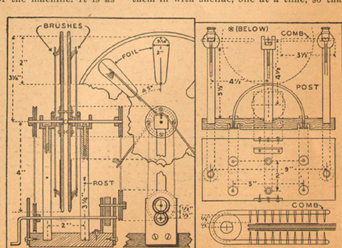
An increased effect is produced by connecting a couple of condensers to the terminals. These are capable of accumulating the charges of electricity until they are full, and then discharging them suddenly in a violent blue spark. (This should on no account be taken through any part of the body, or a severe shock will be felt.)

The type of condenser usually employed is the Leyden jar, shown in Fig. 1. It is quite easy to make one from a preserve jar, as follows: Wash and dry the jar thoroughly, and line it with tin foil to about three-quarters of the way up inside. The easiest way to do this is to cut up several small strips of tinfoil and stick them in with shellac, one at a time, so that they overlap one another. Then the outside of the jar is coated to the same level, in the same way. The cork, or vulcanite stopper, carries a short brass rod with a ball on its upper end. The lower end must make some sort of metallic contact with the inner coat of foil, the simplest way being by means of a short chain.

When two of these jars have been made, connect the brass rods or balls with the two terminals, or the comb-bearers, of the machine; and either ground their outer coats, or connect them together by standing both jars on the same strip of metal. The machine will now produce the large sparks at about one-second intervals; the size (but not the length) of the sparks, and the interval, depending on the capacity of the Leyden jars used.—*Practical Mechanics.*

Fig. 4 (left) General details of the Wimshurst machine disc and its mountings; also the methods of connecting the brushes. It will be observed that the brushes on opposite sides are set at right angles to each other, not opposite.

Fig. 3 (right) Setting the posts into the base, and also details of the combs which collect the charge excited by the brushes.



WARNING!

American experimenters, when constructing static machines, usually meet with failure in that they cannot get the machines to operate. The reason for this is found in the American glass used in the Leyden jars. This is usually of the lead glass variety. It is absolutely no good for static machines as such glass does not hold the charge inasmuch as it is conductive to the high frequency static discharge. You must use potash glass, or the variety known as Pyrex. Ordinary test tubes and chemical glassware made in this country is all of the lead glass variety and cannot be used.

Electrical Hands

(Continued from page 489)

above the radio set (shown in the upper picture) and, when the sign in this indicates that it controls the desired mechanism, makes another motion starting the "buzzer," "lights," "radio," etc., indicated in the window. This ingenious, though not costly, mechanism was arranged by James S. Doyle, a New York engineer.

Bottle Cap Contest

(Continued from page 505)

lite, hard rubber, wood, or cardboard bracket, which should be hinged together, or cemented if desired. A small slot is cut into the top, the inside lined with felt—and an admirable desk holder for a watch is the result.

Fig. 5 illustrates the use of a bakelite top as a drawer knob. Similarly, this same set-up can be used for making a radio dial or switch control. A hole may be drilled through the top, a nickel-plated screw dropped through it, a small metal tube added; a washer and a nut complete the assembly.

The tops of toothpaste tubes, if round, make good wheels for toy trains or rolling toys. They should be drilled in the center, a rod inserted, and the ends filled with a suitable cement, which may be melted resin, sealing wax, lead, or an alloy. This construction is illustrated in Fig. 6.

Should you break the mirror of your microscope, get a cap to fit in the fork, drill two small holes diametrically opposite each other, then cement a good mirror from the milady's handbag into the cap. See Fig. 7.

Fig. 8 discloses a repair to a graduate with a broken base. Stand the graduate in a cap, and pour in some plaster of Paris mixed into a creamy paste with water. Make sure, however, that the cap is flat on the bottom; if not, straighten it with sandpaper or a file.

A simple stand of wood, bakelite or metal, fitted with a glass, will make a miniature mount for a desk picture. A better combination would be to use polished aluminum, silver or brass for the standard, and a black cap. Hold the cover glass in place by small metal lugs, wooden wedges, or a metal bezel.

The construction of artistic picture books is illustrated in Fig. 10. Stiff wire is bent as shown; the small projection forms an anchorage for a bakelite cap, which is held in place by filling with plaster of Paris, resin, or sealing wax.

If you have an ordinary umbrella fitted with a rather crude handle, you can enhance its appearance by adding an ornamental top of bakelite or composition. Some tops are truly beautiful (for example, those found on ink bottles). Cut the wood down so that it will fit the top tightly; then screw the top onto the wood, which operation, if carefully done, will cut the threads. Remove the cap, fill it with a waterproof glue, then replace. Now drill a hole through cap and umbrella, and insert carrying cord.

These ideas are offered merely as suggestions but we feel that those you submit will be even better. None of those outlined will be awarded prizes.

Mechanics of Magic

(Continued from page 500)

lows the air to escape through the rubber hose, permitting the balloon to diminish, and (apparently) finally vanish.

The Jumping Fountain Pen

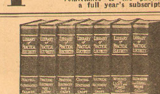
The wizard, after showing both hands quite empty and unprepared, closes the fingers of his right hand to form a fist. With his left hand, he proceeds to slowly push a fountain pen or pencil, half-way down into the fist, the upper part protruding. At his command, the fountain pen mysteriously leaps high into the air, and he catches it upon its descent. It is at once passed for inspection. Any pen or pencil may be used, and the experiment may be successfully repeated as often as desired.

The magician wears a false finger (what is professionally known as an "extra finger") made out of a piece of brass tubing, and painted flesh-color, to resemble his own. Worn between the second and third fingers of his left hand, it is quite unnoticed at a short distance, when the fingers of both hands spread wide apart, are nonchalantly displayed.

A very weak spring, with a plunger top, is concealed inside the finger. Thus, in presenting the trick, the finger is held in position secretly in the closed hand, so that the pen, being pushed into it forces the plunger down. The pressure of the thumb and first finger, upon the pen, prevent it from flying into space, until the leap is desired. At the conclusion of the trick, the finger is secretly pocketed or palmed, as the performer chooses.

Rapid-Transit Playing Card

A small stand (of the design illustrated) is located on the magician's table. An envelope is freely chosen, from a stack of twelve, which have been passed for inspection. The chosen envelope is then sealed and, without exchange, is placed in position upon the stand. The magician places a strong electric lamp reflector directly in back of the apparatus, so that the rays of the lamp, penetrating through the



Static Machine from Scraps

40,000-Volt Wimshurst Machine Easily Made

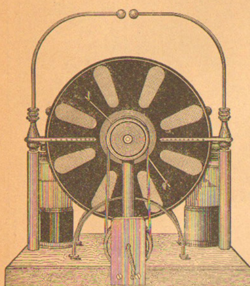


Fig. 1—Front view of the static machine made from scraps.

● A WIMSHURST machine, as shown in Figs. 1 and 2, is simply a mechanical device for rotating in opposite directions two sets of metallic conductors—in this case sectors of tinfoil shellacked to 8" phonograph records—with appropriate apparatus for collecting the electric charges induced on them.

The essential parts of the machine must be perfectly insulated; for which reason they are usually mounted on glass pillars. In this model, vulcanite, hard rubber, or some such composition is used; it must be remembered that dry wood is not a good insulator to high-potential static electricity.

The vulcanite "posts" are 6" radio lead-in tubes. The brass rods and terminals,

(Continued on page 514)

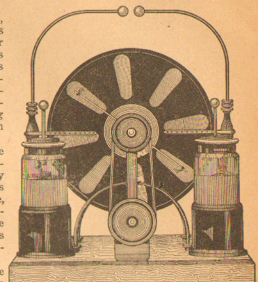
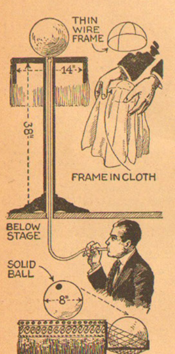


Fig. 2—Back view of the same machine, showing condensers.

Mechanics of Magic

By "DUNNINGER"

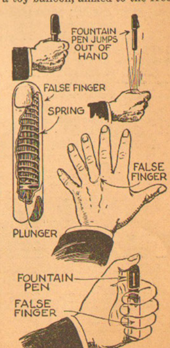


The apparatus used for the disappearing ball.

● IN the "Elusive Cannon Ball" effect, a wooden sphere, eight inches in diameter, is examined. The magician carries it back to the stage and, in order to further prove that no substitution has been made, strikes it several times upon a table top, proving conclusively that the solid ball is actually being used. He now covers it with a large silk cloth, and carries it across the stage to a small undraped side stand. Placing it upon the top of the stand, the cloth is again removed, proving that the ball is still there. It is once more covered and, at the magician's command, the cover is seen to slowly sink, the ball apparently diminishing. The cloth is removed and the large sphere is found to have mysteriously and completely vanished.

The solid ball, after being struck upon the table top, in the act of proving it solid, is covered with the cloth. Beneath this cover the ball is secretly permitted to roll into a *savante* (or bag) attached to the back of the table. A thin wire frame, sewed into the cloth (which is really two squares of cloth, sewed together around the edges, with the frame concealed between them), is carried across the stage, and placed upon the side stand. An assistant, concealed below the stage, blows up a toy balloon, affixed to the free end of a rubber hose, as illustrated. It is really this balloon which the audience sees, and imagines to be the solid wooden sphere, when the cloth is lifted. The ball is again covered, and the understage assistant al-

(Continued on page 515)



The jumping pen is produced by the spring in the false finger.

How a playing card is made to apparently appear in the envelope mounted on the stand.

Static Machine Contest

$100.00 in Prizes

● DURING the recent months, the editors of this publication have received many indications that experimenters are interested in building static machines and experimenting with them. Because of this interest, articles have been recently published on the construction of such machines.

Static machines are used particularly to demonstrate production of electricity in small amounts at high voltages. If well designed and constructed, they give a heavy long spark which, if Leyden jars are added, produces a blue-white crackling flash. These machines can be used for a great many experiments, such as demonstration of "effluve" or electrical flow, charging condensers, lighting neon and Geissler tubes, charging electroscopes, and demonstrating the repellant and attractive nature of charged pith balls, etc.

However, most static machines are expensive to build, even if you make them yourself. Believing, however, that the ingenuity of our readers will considerably reduce the cost of the construction of the machines, making them available to the average experimenter, we have decided to announce a contest, in which prizes will be paid for the five best inexpensive static machines.

Years ago, the editor of this publication designed and built a static machine which used old phonograph-disc records for the plates; this device worked surprisingly well. Other suggestions for reducing the cost of construction will be found on this page. For the rules of the contest, refer to the box in the center of the page.

RULES

This is a Static Machine Contest. Only *working models* of static machines may be entered.

(1) In this contest, you are permitted to enter any type of static machine, either conventional style or a specialized design of your own.
(2) No machine will be considered unless it produces a spark at least 1 inch long, under favorable conditions.
(3) The machine must be made from materials easily obtainable, preferably scrap and used parts. Glass should not be used in its construction, with the exception of the condensers; and even these should preferably use mica.
(4) The weight of the machine, excluding the weight of drive, should not be more than five pounds. Either hand-operated or motor driven mechanism may be added. Machines must be sent by mail or express; drawings or photographs will not be accepted.
(5) In a short, brief article, set forth the construction of your machine, and submit with your entry.
(6) For the machine which produces the longest and heaviest spark, within the conditions of this contest, the first prize of FIFTY DOLLARS will be paid; for the machine which produces the next longest and heaviest spark, the second prize of TWENTY DOLLARS will be paid, etc. There are five prizes; but in the event of a tie for any of the awards, the full amount of the prize will be paid to each contestant so tying.
(7) The editors of this magazine will be judges, and their findings will be final.
(8) The first three prize-winning models will not be returned to the prize winners. All other entries will be returned, provided return postage is included at the time of entry.
(9) This contest closes in New York on October 10, 1934, and all entries must be in our hands at that time.
(10) The employees (and their families) of EVERYDAY SCIENCE AND MECHANICS are excluded from this contest.
(11) Address all entries to Static Machine Editor, c/o Everyday Science and Mechanics, 99 Hudson Street, New York, N. Y.

PRIZES

First Prize	$50.00	Fourth Prize	$10.00
Second Prize	20.00	Fifth Prize	5.00
Third Prize	15.00	Total	$100.00

We will now refer to the various items. Fig. 1 illustrates the construction of discs from cardboard. Three discs of cardboard should be cut out and thoroughly dried in a stove; then impregnated with shellac, and bound together with the same substance. A coating of sealing wax can be applied to the outside by melting the wax on the disc when the disc is hot. Only one side need be coated. However, even shellac itself will be found serviceable in most instances, and the sealing wax coating need not be applied.

Fig. 2 shows how tinfoil collectors can be applied to a phonograph disc. They may be best held in place with shellac as an adhesive.

Fig. 3 demonstrates how a number of tinfoil sectors can be cut at one and the same time, using an old radio condenser to supply the tinfoil. The condenser is first removed from its case, the shape of the sector marked on the surface, and then a sharp knife is used for cutting completely through the body of the condenser. The sectors should not be wider than the

(Continued on page 516)

Fig. 1—How to make discs for your static machine.

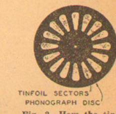


Fig. 2—How the tinfoil sectors are placed on the discs.

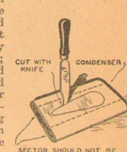


Fig. 3—Cutting many tinfoil sectors at one time.

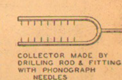


Fig. 4—The construction of a collector is here given.

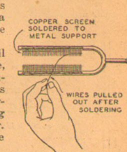


Fig. 5—Another and easier method of making a collector.

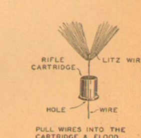


Fig. 6—This is a simple method of producing brushes.

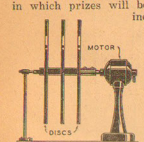


Fig. 11—Discs in parallel, mounted on motor shaft extension.

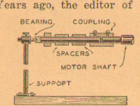


Fig. 12—Cross-section of arrangement illustrated in Fig. 11.

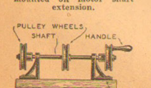


Fig. 10—One of the simplest methods of making a drive.

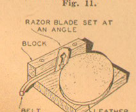


Fig. 9—How to make long leather belts from a leather disc.

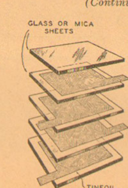


Fig. 8—The construction of a simple condenser is here illustrated.

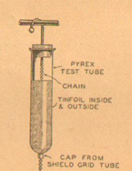


Fig. 7—This Leyden jar is designed to be suspended from a collector.

July 1916

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Everyday Mechanics

EDITED BY
THOMAS STANLEY CURTIS

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Vol. 1 JULY, 1916 No. 5

CONTENTS

(*Continued on following page*)

The Editor will be glad to receive original contributions which tell how to make or how to do some useful thing. The material may be either in the form of a complete article or else merely an idea written in the form of a letter. Available material will be paid for liberally and promptly and all manuscript will have immediate consideration. Return postage should invariably be included to insure safe return of unavailable material.

CONTENTS—*Continued*

STATEMENT OF OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, of EVERYDAY MECHANICS published monthly at New York, N. Y., for April 1, 1916. State of New York, County of New York,

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Wm. R. Bowen, who, having been duly sworn according to law, deposes and says that he is the Business Manager of the EVERYDAY MECHANICS and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management etc. of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Everyday Mechanics Company, Inc., 33 West 42d Street, New York, N. Y.; Editor, Thomas Stanley Curtis, 153 East 18th Street, New York, N. Y.; Managing Editor, Thomas Stanley Curtis, 153 East 18th Street, New York, N. Y.; Business Manager, Wm. R. Bowen, 511 West 146th Street, New York, N. Y.

2. That the owners are: (Give names and addresses of individual owners, or if a corporation, give its name and the names and addresses of the stockholders owning or holding 1 per cent. or more of the total amount of stock). Everyday Mechanics Company, Inc., 33 West 42d Street, New York, N. Y.; Emil Schramm, 2249 Tiebout Ave., New York, N. Y.; Thomas Stanley Curtis, 153 East 18th Street, New York, N. Y.; Wm. R. Bowen, 511 West 146th Street, New York, N. Y.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent. or more of total amount of bonds, mortgages, or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

WM. R. BOWEN (Signature of Business Manager.)

Sworn to and subscribed before me this 5th day of June, 1916.

(Seal.) JULIUS LEVY, No. 122.

(My commission expires March 30, 1918.)

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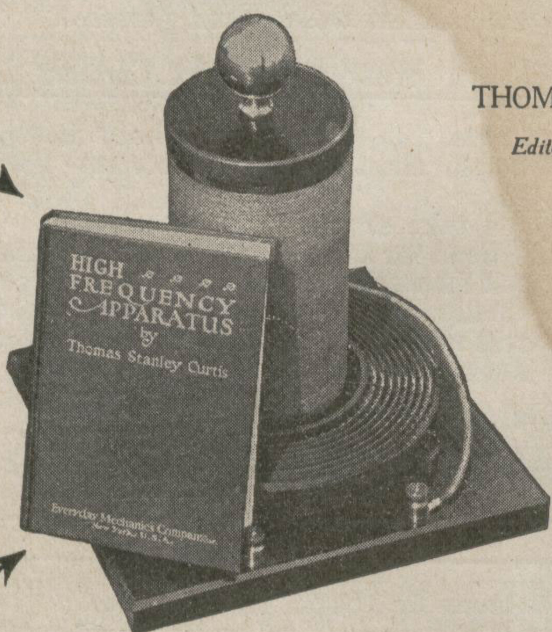
High Frequency Apparatus

Its Construction and Practical Application

By
THOMAS STANLEY CURTIS
Editor of "Everyday Mechanics"



The most comprehensive and thorough work on this interesting subject ever produced. The book is essentially practical in its treatment and it constitutes an accurate record of the researches of its author over a period of several years during which time dozens of coils were built and experimented with.

CHAPTER HEADINGS

I. The Alternating Current at Low and High Frequencies. II. How the High Frequency Current is Produced. III. Some Points in the Construction of High Frequency Apparatus—The High Potential Transformer or Induction Coil. IV. Oscillation Condenser. V. Spark Gaps. VI. Oscillation Transformers. VII. Experimental High Frequency Apparatus—Induction Coil Outfits Operated on Battery Current. VIII. Kicking Coil Apparatus. IX. One-half Kilowatt Transformer Outfit. X. Quenched Gap Apparatus. XI. Electro-therapeutic and X-Ray Apparatus—Physicians' Portable Apparatus. XII. Physicians' Office Equipment. XIII. Hot Wire Meter Construction. XIV. Notes for the Beginner in Electro-therapeutics. XV. Practical Electro-Horticulture or the Cultivation of Plants with Electricity—Plant Culture with High Tension Current. XVI. High Frequency Plant Culture. XVII. High Tension Electrical Stagecraft—A Foreword on the Construction of Electrical Apparatus for the Stage. XVIII. Construction of Large High Frequency Apparatus. XIX. Large Tesla and Oudin Coils for the Stage. XX. Construction of a Welding Transformer. XXI. Hints for the Electrical Entertainer. APPENDIX. Parts and Materials—How Much They Cost and Where to Get Them.

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EXPERIMENTAL HIGH FREQUENCY APPARATUS

By The Editor

I WANT to tell you, in this article, about that fascinating, elusive, and altogether puzzling form of electrical energy known as an alternating current of high potential and high frequency. The study of high frequency phenomena has afforded me many an hour of the keenest pleasure and interest, to say nothing of profitable employment, and I feel that a discussion of the startling characteristics of this current, together with a description of the apparatus necessary for its generation, cannot be without a certain degree of value to readers of Everyday.

A review of my correspondence of three years past convinces me that in treating of high frequency apparatus in various articles, I have fallen into the common error of assuming a certain breadth of knowledge on the part of my readers that they do not possess. And, strangely enough, this dearth of knowledge appears to be due, not to the complexity, but to the utter simplicity of the apparatus in its experimental form.

Accordingly, it is my intention to tell, not of the theory and mathematics of the high frequency current, but what the current is, how it is used, what it will do, and how to produce it. The apparatus required is not expensive and neither is it difficult to make in the amateur's workshop. Hence, when once he has learned what wonderful results he can obtain and what startling experiments he can perform with the crudest instruments imaginable, I believe my reader will agree with me that there is no more interesting or entertaining branch of electrical science than this which deals with alternating currents that oscil-

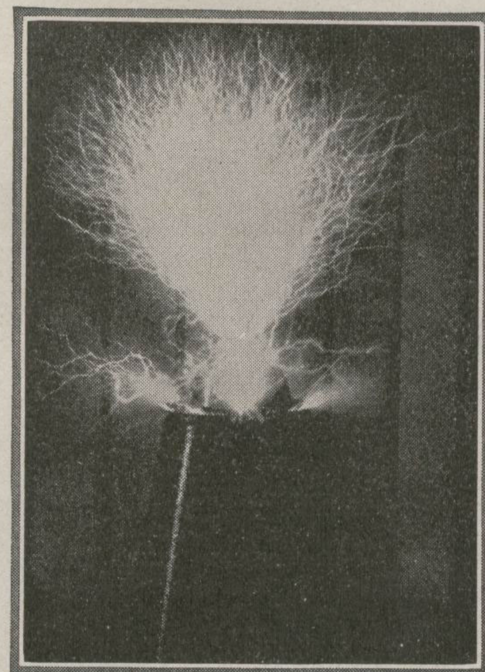


Fig. 1. Great streamers of fire reach out from the terminal

Fig. 2. The high frequency current is harmless to the human organism

late with a frequency of perhaps a million cycles per second.

It is safe to assume that a goodly portion of my readers will understand what is meant by an alternating current of electricity. For the benefit of those who do not, however, it may be de-

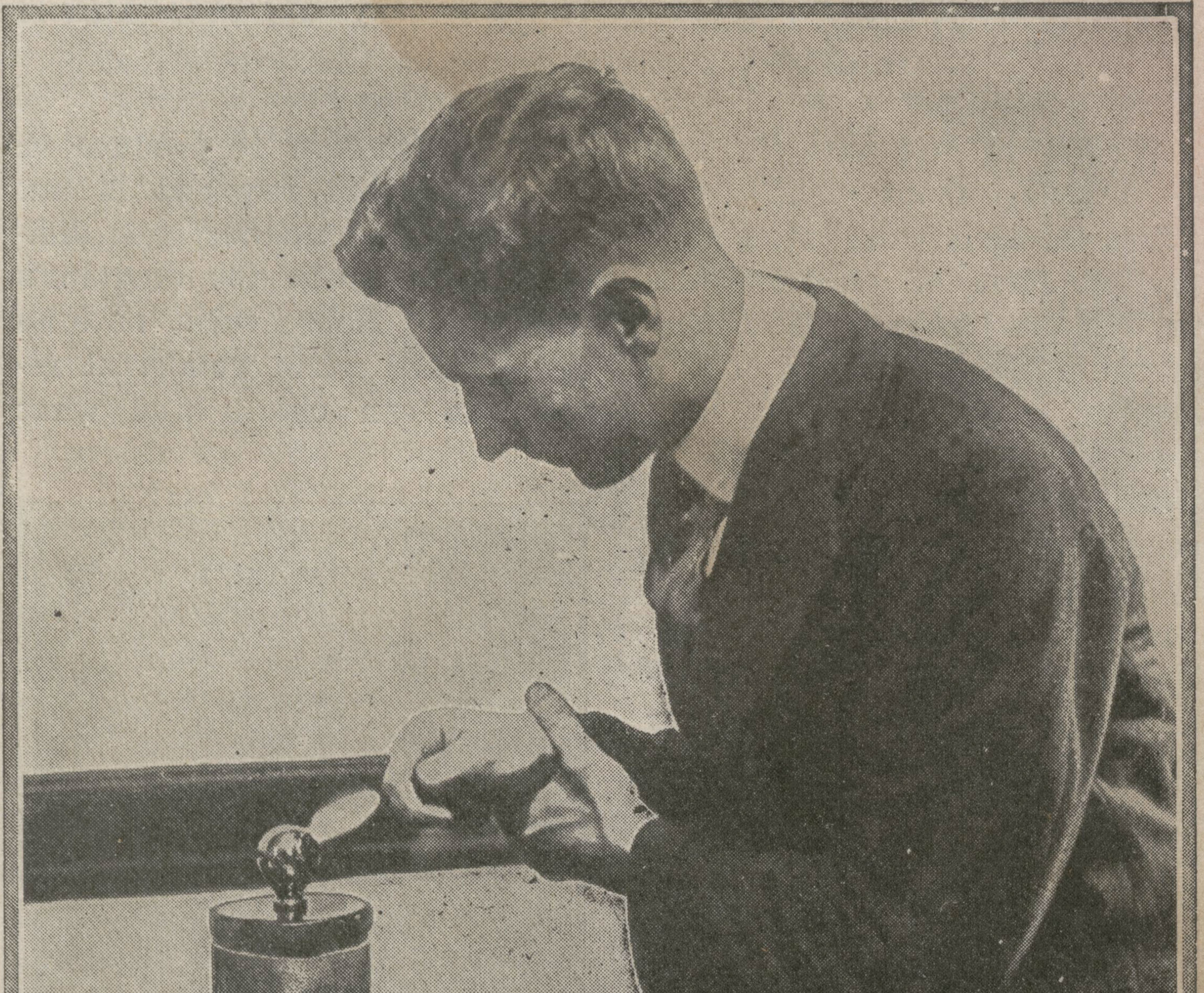


Fig. 2. The high frequency current is harmless to the human organism

fined briefly as a current which periodically changes its direction of flow a certain number of times per second. Commercial currents, which light our homes and offices, run our fans, etc., if alternating, may change their direction of flow from 120 to 250 times per second; these currents would be described as 60 or 125-cycle currents, because, in the case of the 60-cycle current, for instance, the current would alternate 120 times or make 60 complete cycles or reversals from positive to negative and from negative to positive, in the space of one second.

Such a current possesses certain well-known characteristics which make it dangerous when applied to the body at pressures exceeding 110 or, at the most, 220 volts. The passage of the current is accompanied by a disagreeable sensation of "shock" or contraction of the muscles; if the voltage is sufficiently high to force even a tenth of an ampere through the body, the shock is frequently fatal. The physiological result is a paralysis of the muscles of the heart, and the injury which follows is caused literally by suffocation. In addition, the point of contact with the current-carrying wire is seared and burned if the contact is sufficiently long and the current strong enough.

Now, if we take that 60-cycle current with its dangerous and painful characteristics, and, by means of certain simple apparatus, make it increase in frequency or number of reversals per second until the periodicity reaches ten or fifteen thousand cycles per second, we change its characteristics as if by magic!

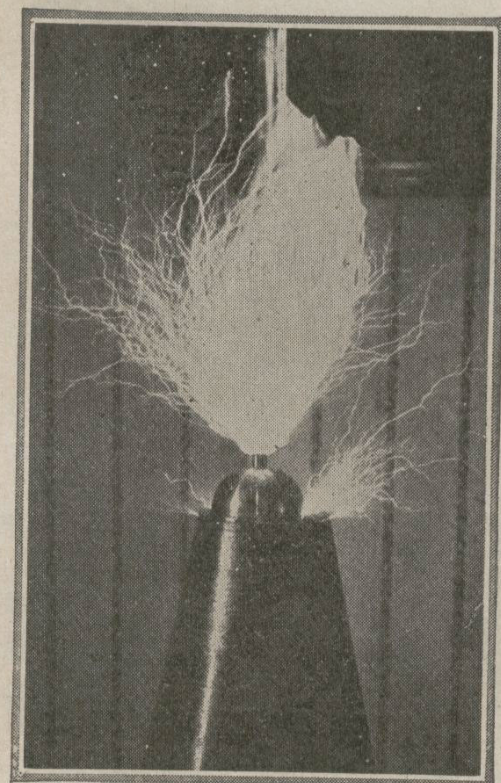


Fig. 3. The discharge leaps through 2 ft. of air to a "grounded' wire

No longer is it painful when applied to the human body and no longer is it dangerous. We can increase the voltage of the current until it will leap across a gap of several inches or even feet in length with a crashing blue-

white flame, and still this stupendous exhibition of the discharge of seemingly stored-up energy is as harmless as the bite of the proverbial barking dog.

Fig. 4. Homemade lighting. Three instantaneous discharges of the coil

Instead of the death-dealing shock and paralysis when applied to the body, we have a sensation of the gentlest warmth, with a constructive effect upon the human organism instead of a destructive one.

If we were to apply the ordinary 60-cycle current to the ends of a helix composed of four or five turns of heavy wire, the result would be a dead short circuit; let us apply the high frequency current, and we find not a short circuit but a difference of potential of perhaps thousands of volts between the terminals of the helix. Let us hold a single turn or ring of wire over that helix while the high frequency current is passing and we find that a current of perhaps a hundred volts is induced *in that single turn of wire;* to prove it, we may light a 110-volt incandescent lamp by touching the ends of the ring of wire to the terminals of the lamp. Think of it—a lamp lighted by the current induced in a single turn of wire totally devoid of any connection with the main circuit, but merely held over the helix through which the high frequency current is passing.

If the high frequency transformer is permitted to discharge through the air, or, indeed, *into* the air, the discharge takes the form of a myriad of snapping, snarling sparks and tongues of flame. In the pictures reproduced herewith, we used but 300 watts of electrical energy. This same quantity of electricity at commercial frequencies would not begin to produce this spectacular display but it might be

infinitely more dangerous in its quiet flame-like discharge at high voltage.

If one terminal of the high frequency coil is connected with a piece of bare wire suspended from the ceiling with thread or cord and the coil set in operation, the wire will glow with a weird, purplish light and tiny forks of flame will dart from every angle. A most interesting experiment, for which I am indebted to Dr. Frederick Finch Strong, is that of connecting the terminal of the coil to the steel rod of an umbrella and hanging the umbrella from the cord in an inverted position. Every rib stands out in purple fire while the little tongues of flame dart from the tip of each rib.

The experiments are not confined to such applications. The high frequency current, when taken through the body by means of suitable electrodes and appliances, acts as a tonic, building up the system and improving general nutrition. Applied to the body as a condenser, the current serves to reduce blood pressure and its use in cases of arteriosclerosis or hardening of the arteries has proven a boon to suffering humanity. The current produces admirable X-ray pictures and in this connection it is said to be less dangerous by far than the usual procedure with an X-ray tube excited with a direct current. Applied to the scalp through the medium of a vacuum electrode, the current stimulates the growth of hair by increasing nutrition and by massaging every tiny cell.

Passing from the physiological or therapeutic side of the current, it is capable of cultivating plants and vegetables, stimulating their growth to such an extent that they mature in half the normal time. Discharged through the air, the current liberates great quantities of ozone. Discharged into an antenna or aerial of overhead wires, the current sets up vibrations of the ether which extend into almost infinite space and give us what you have

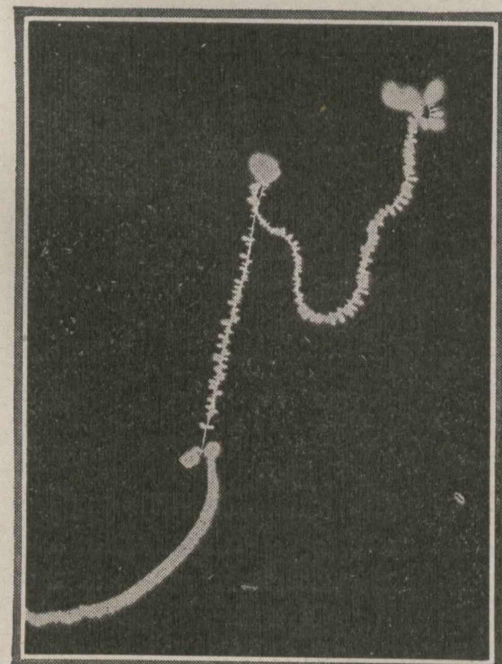


Fig. 5. A real "live" wire. How a wire charged with high frequency current looks in the dark

all heard of and what most of you play with—radio telegraphy.

Now, with that prodigious list of accomplishments to its credit,

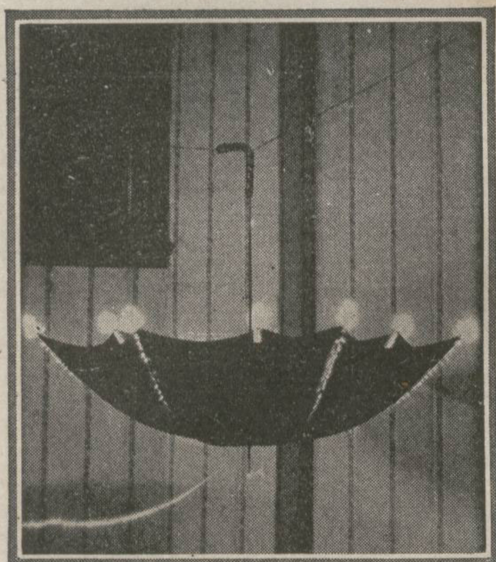


Fig. 6. Frame of umbrella charged with high frequency current

do you not agree that the experimental study of this current and the apparatus that generates it is fully worth while?

How the Current is Generated.—For all practical purposes of the experimenter and student, there is but one generator of high frequency currents available. This is the form most commonly used by wireless amateurs throughout the country. The generator consists merely of some instrument of producing a high potential such as an induction coil or a transformer, a condenser in which to store this current at high voltage, a spark gap across which the condenser may discharge, and a suitable oscillation transformer or high frequency coil to raise the voltage of the high frequency current set up by the discharge of the condenser across the spark gap. That, in a nutshell, gives you the salient features of an experimental high frequency generator.

In view of the fact that the average radio amateur is very likely to have in his possession the exciting portion of the apparatus comprising the transformer or induction coil, condenser, and spark gap, I will pass over the description of these instruments in this article and confine my description to the oscillation transformer which is the one part of the apparatus that seems to trouble the experimenter; in reality it is the very acme of simplicity, both in principle and construction.

Fig. 7 shows a little resonator or oscillation transformer of the Oudin type, so-called because of its originator. This transformer consists merely of a primary coil of brass ribbon wound into a spiral, and a secondary coil of a single layer of cotton-covered magnet wire wound upon a cardboard cylinder. The lower end of the secondary winding is joined with the inside turn of the primary spiral. That is all there is to the coil so far as the basic principle is concerned. The refinements to be described are

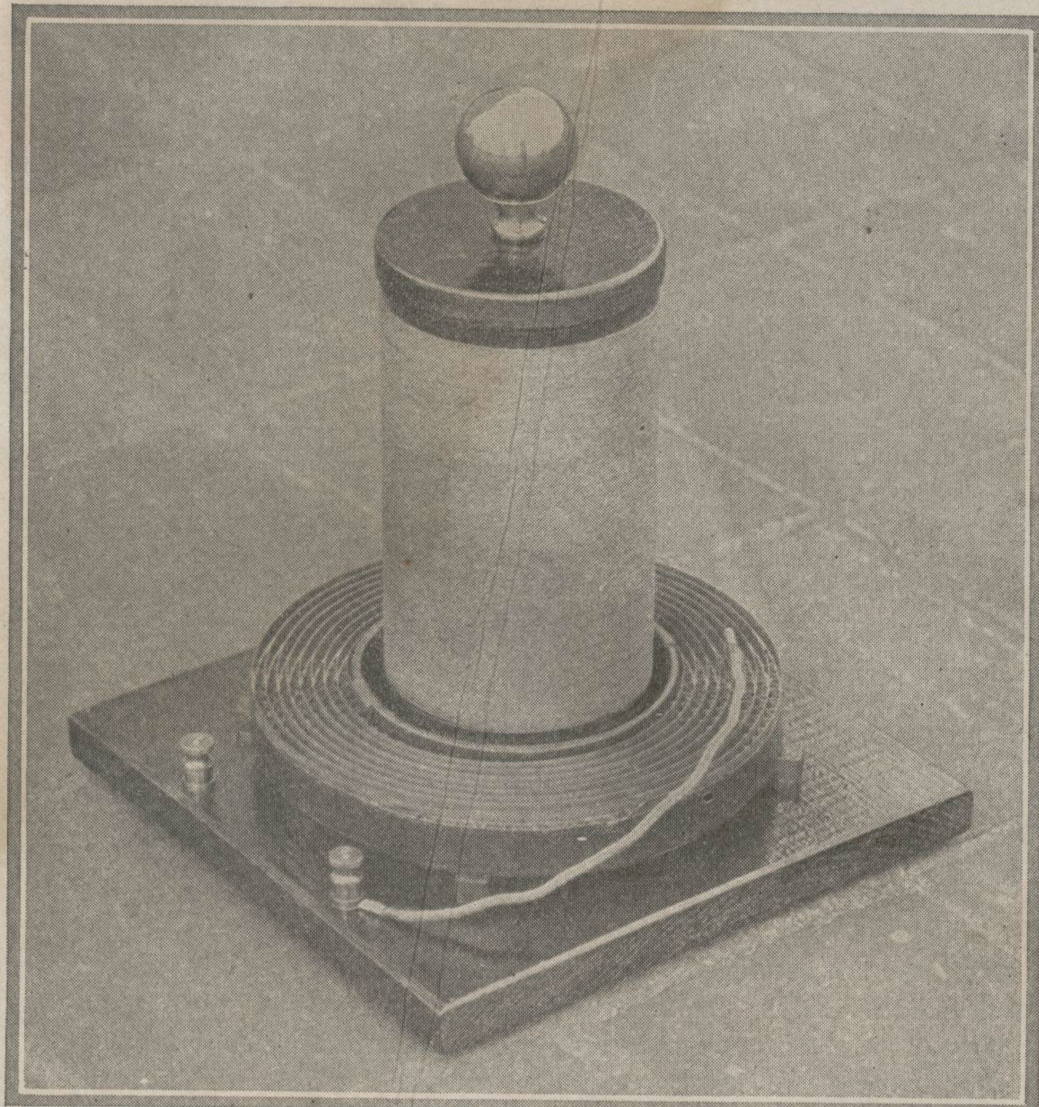


Fig. 7. A small coil suitable for use of amateur, lecturer or class-room instructor It will throw a 12-in. discharge

in the nature of conveniences which make the outfit more efficient, better adapted to demonstration work, and of a more workmanlike appearance.

This transformer will throw a spark 12 in. in length when used with a standard ¼ K. W. wireless transformer. The spray discharge reaches out to a greater distance if the coil is carefully "tuned." By tuning is meant the moving of the clip connector from one turn of the primary coil to another until the point of "resonance" is found.

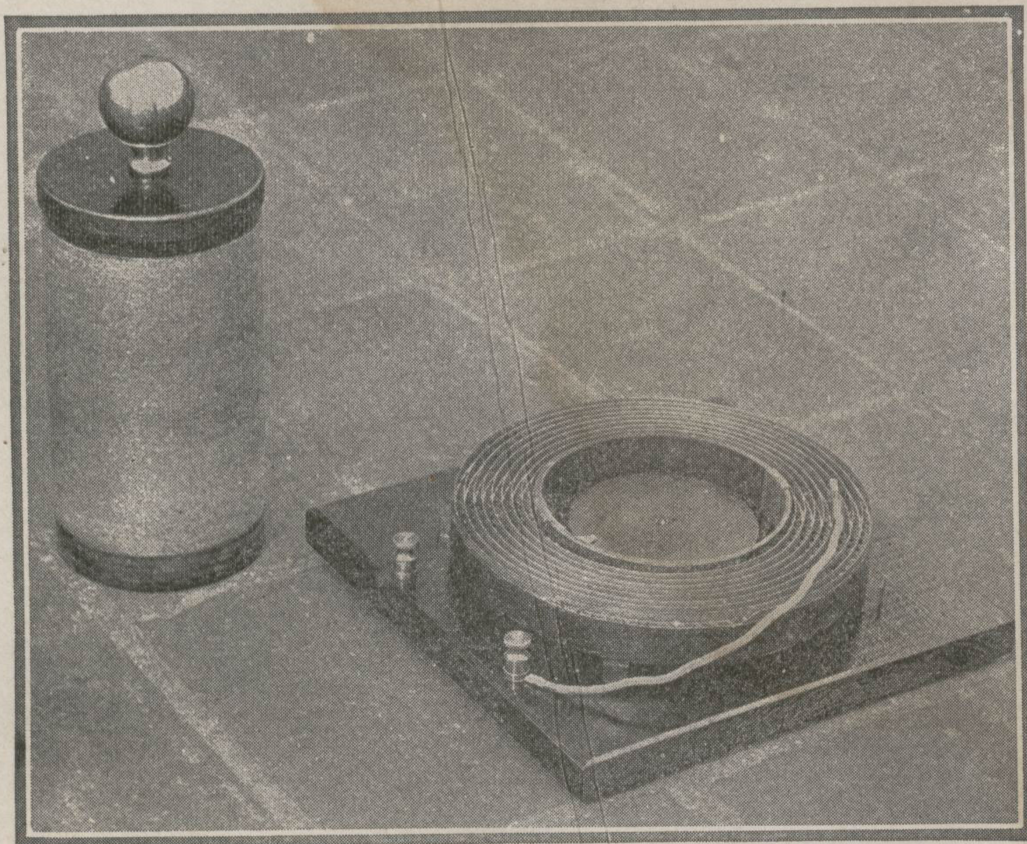


Fig. 8. The secondary may be removed for induction experiments

Perhaps the most novel feature of the little coil is the fact that the secondary lifts out of the primary, leaving the latter free for use in connection with experiments showing the principle of induction or how a current is induced in a coil of wire held over the primary.

Figs. 9 and 10 show clearly the details of construction of the oscillation transformer. The reader will see that the construction is very simple. The wooden heads for the cardboard cylinder may either be turned up on the lathe or else cut with a jig saw. The latter does not make as nice a job but it is perfectly satisfactory for all that.

The cardboard cylinder is a stock article that may be procured from advertisers in EVERYDAY MECHANICS or else through our Service Department. It is perfectly smooth and ready to be wound. I suggest this because it is difficult to get anything in the open market that will answer the purpose of the paper cylinder; wood will not do as it changes its size so materially with changes

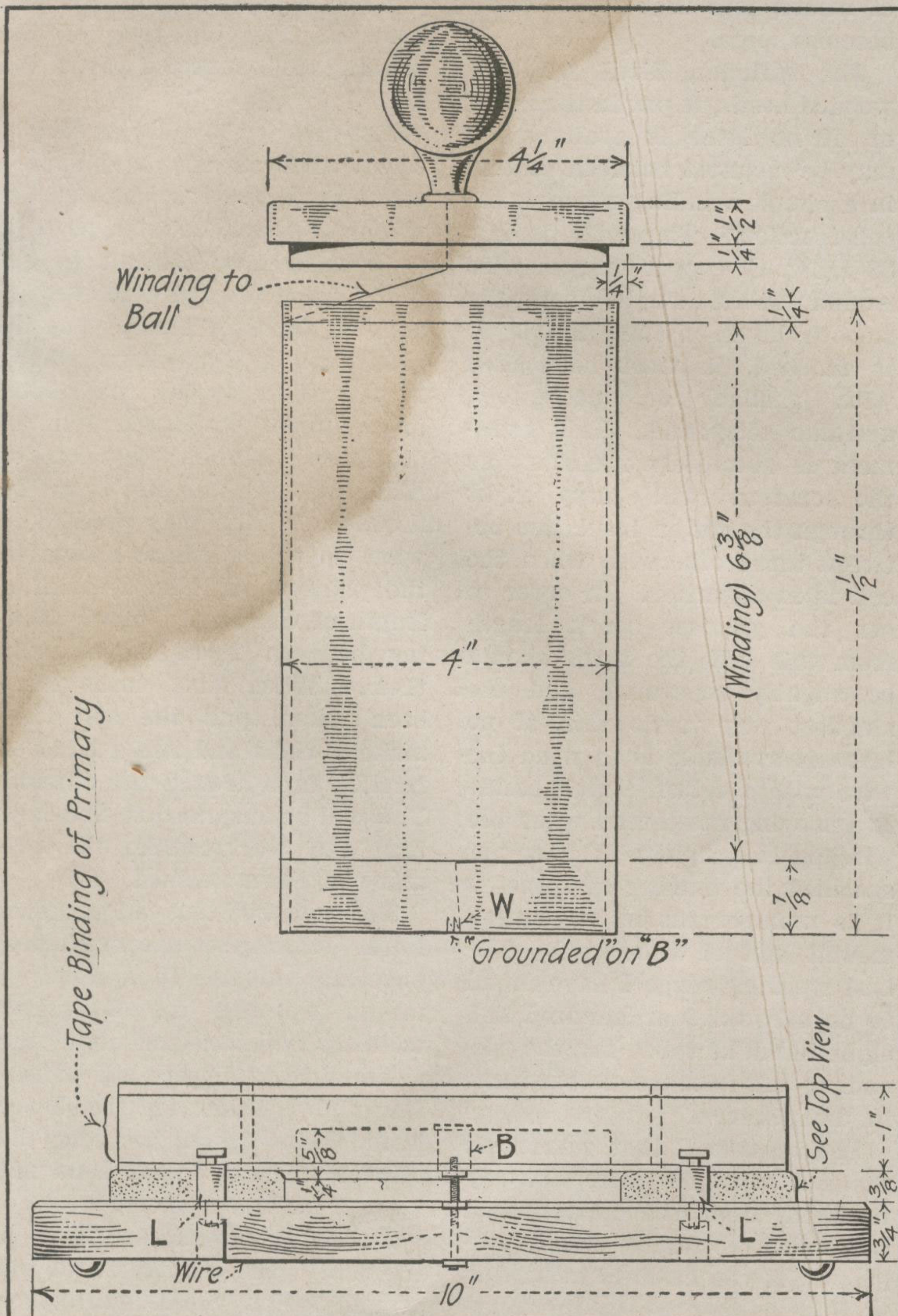


Fig. 9. Details of construction

of atmosphere that the winding becomes loose.

The cylinder, fitted with its wooden heads, is put in the lathe, or, if no lathe is available, it may be mounted between centers in a simple winding rig of home construction. The wire is No. 28 D. C. C. copper magnet wire wound in a single, perfectly smooth layer. When the layer is finished, it must be soaked with shellac, or, preferably, armalac compound. This treatment is absolutely necessary as the current will jump right through the cotton insulation between turns otherwise when the coil is in operation. In order to get the greatest spark length from this coil, the turns should be slightly separated, and the simplest way to do this, if no lathe is available is to wind the wire with a cotton thread beside it, removing the thread when the winding is complete. I have not specified the number of turns as it is unimportant in an experimental coil of this kind. The best working range I have found to be between four hundred and eight hundred turns for the secondary and from five to ten turns in the primary.

The brass ball that surmounts the coil may be surreptitiously removed from the nearest bed post when the family is not looking; or, if you hesitate to borrow in this manner, go to the nearest five and ten-cent store, and you may find something that will answer. The top turn of the winding is connected with the ball.

The primary is quite as simply constructed as the secondary—only more so. Copper ribbon would be better, but it is so high in price and so difficult to get that I have discarded it temporarily in favor of brass. The inside turn of 1-in. brass ribbon is started by taping the ribbon to a ring of cardboard 5 in. in diameter. Placing the coil of ribbon and the ring flat upon the floor, the builder may proceed to wind up the spiral as shown in the photograph, Fig. 8, with a length of corrugated paper packing between turns to separate them. When nine turns have been taken, pull the spiral to make it tight and run a band of friction tape around the outside. You will be surprised to find how firm and workmanlike the primary is when finished.

The "ground" connection shown in the drawings is a convenience, pure and simple. It is simply a means whereby the secondary winding is connected with the primary by the mere act of setting the cylinder on the lower head. The drawings show the scheme so clearly that I do not need to add much more.

Two binding posts are used on the base. One connects with the ground point, while the other connects with a length of flexible

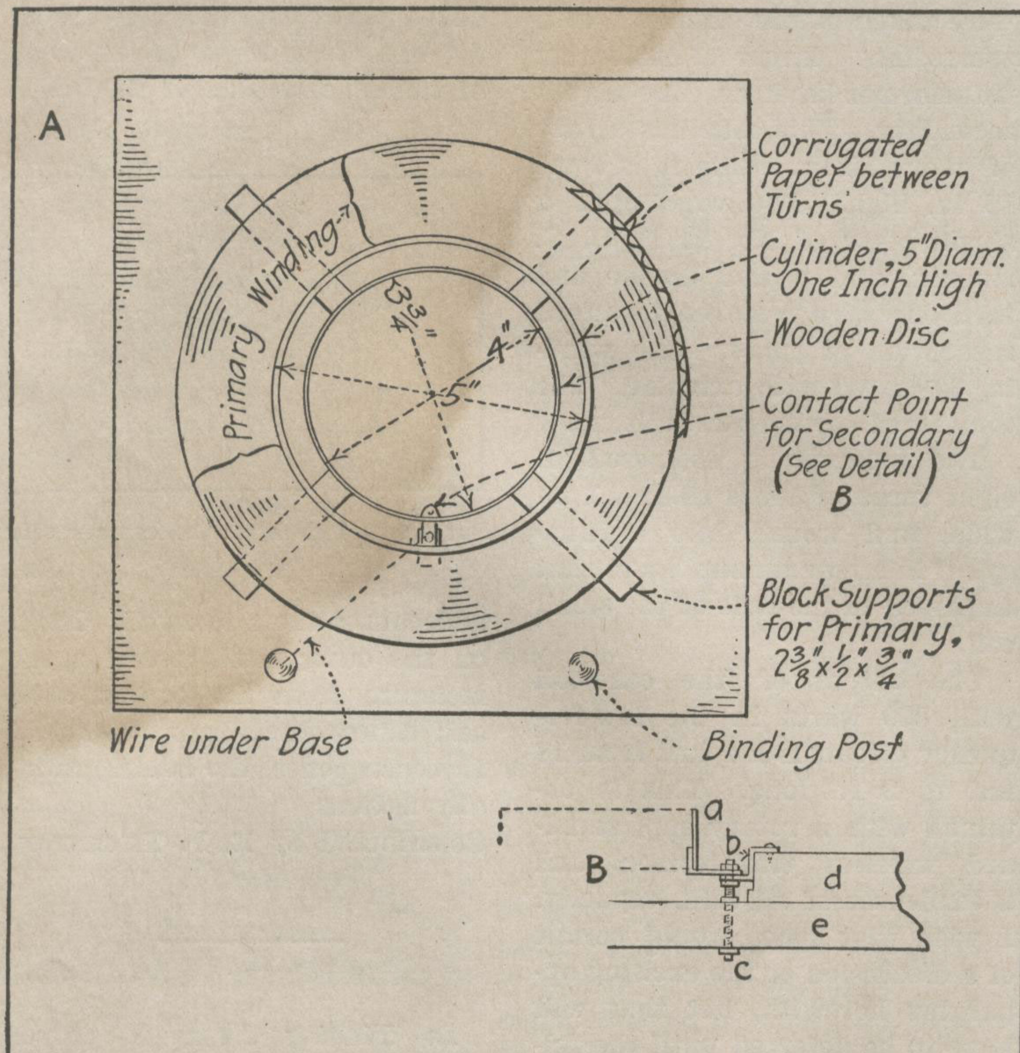


Fig. 10. Detail of primary and "ground" connection

conductor that terminates in a clip to slip over the proper primary turn. The circuit is the usual one with the primary of the oscillation transformer inserted in place of the wireless helix.

This oscillation transformer is large enough for all practical purposes of the average experimenter. It will produce long sparks of good quality, generate a sufficiently high potential for X-ray work, excite vacuum tubes for electro-therapeutic or demonstration purposes, furnish current for experiments in electro-horticulture, etc. Altogether it is a most practical and useful, though inexpensive, piece of apparatus.

The photographs of the spark

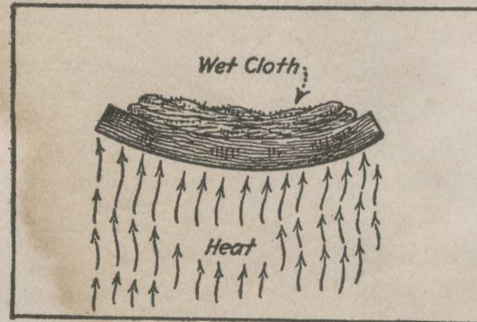
pictures reproduced herewith were taken of the discharge of a somewhat larger oscillation transformer having a cone-shaped secondary. This cone has a base of about 12 in., while it is some 18 in. high. The winding is a single layer of No. 24 D. C. C. magnet wire wound double and then one wire removed to afford separation of turns. The winding is coated with armalac. The cone is of cardboard, built up.

The primary is composed of eight turns of brass ribbon, 1 in. wide, and wound into a large spiral in a manner similar to that employed in the case of the small coil.

The output of the cone-coil with 300 watts in the low-frequency circuit is a spark from 18 ins. to 2 ft. long. This is obtained with a rotary gap, standard wireless transformer, and a condenser of .01 mfd. capacity. I wish that space would permit of a discussion of the exciting apparatus herewith, but that will have to be deferred until the following issue.

To Flatten Warped Board

The amateur craftsman is sometimes in doubt how he can flatten a board that has warped. One way is to lay a thick mass of wet sawdust, or a thickly folded wet cloth on the concave side, and expose the convex side to gentle heat or very dry air. The moisture enters the fibers of the wood of the concave side of the board



Put the wet cloth on the concave side

and causes them to swell. Heat, on the other hand, removes the moisture from the convex side, and causes the fibers to shrink. In consequence, the board gradually flattens.

Contributed by E. P. Thornton.

In Tinning Lugs, if proper methods are not used smooth surfaces will not be obtained. The following has proven a successful method: The lug should be thoroughly cleaned of oil and dirt, dipped in flux and held in molten solder until it is hot. When hot it should be taken and wiped of all excess solder with a rag, not waste, as lint from waste sticks in solder.—H. L. Baer.

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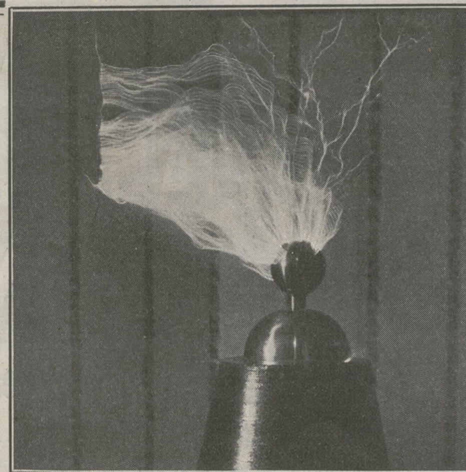
HIGH FREQUENCY APPARATUS

By Thomas Stanley Curtis



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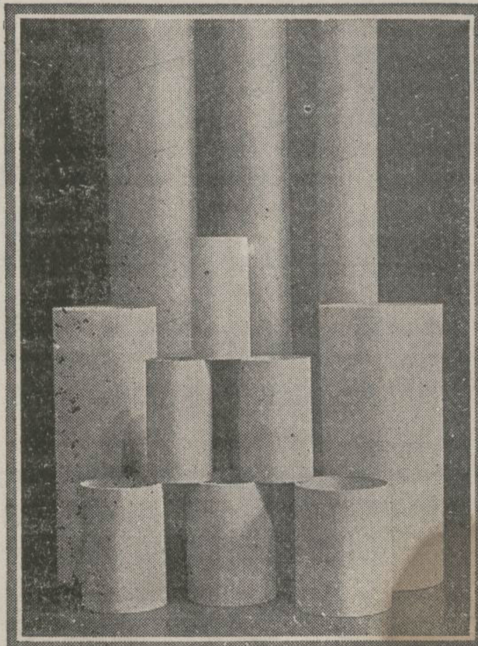

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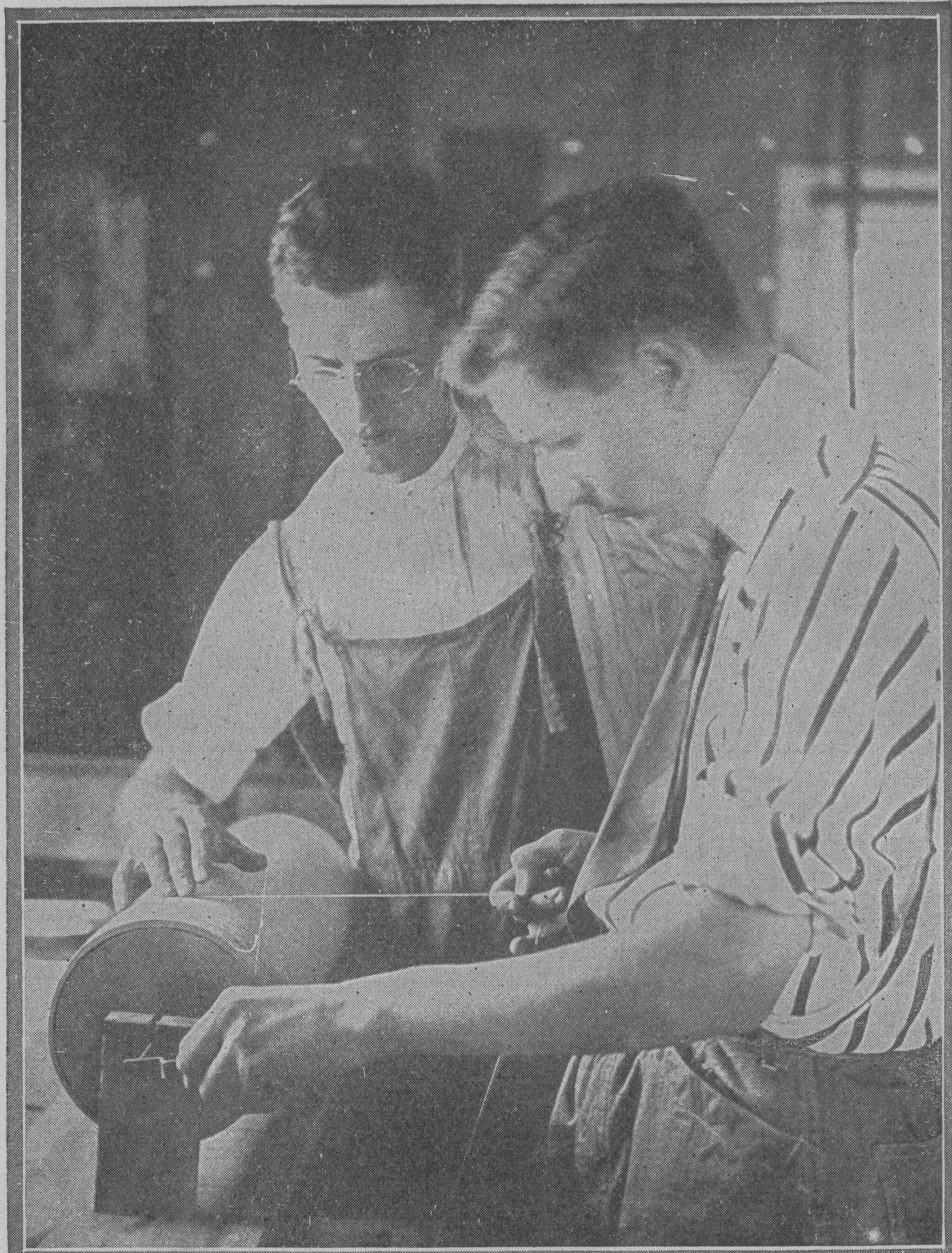
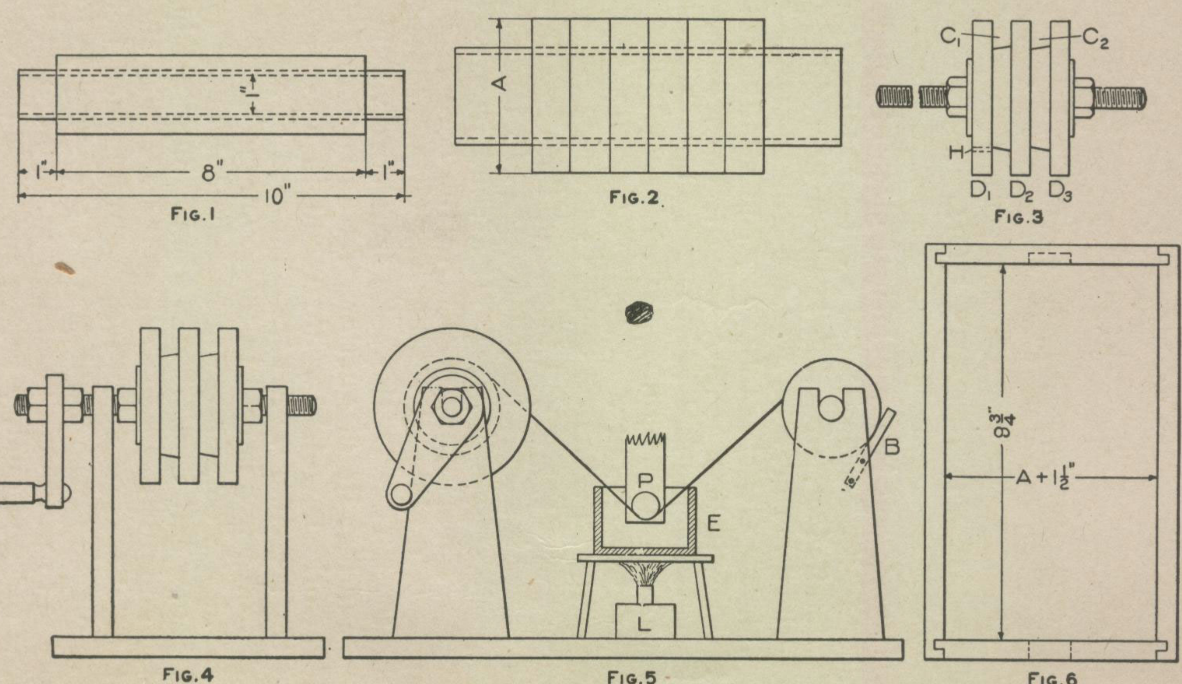


Fig. 3. Starting the winding. Note how the wire is guided



Method of Winding Coils

Another demonstration that gave the audience many thrills was that of the electric chair. This was an ordinary chair with metallic plates fastened on the arms. These plates were connected to the terminal of the conical Oudin coil. The chair was placed on the insulated base, and when operated eight- to ten-inch sparks leaped from the metal parts. After receiving no offers from members of the audience to sit in the chair, one of the assistants was used as the "victim." The person sitting in the chair felt no discomfort as long as the hands grasped the metal arm plates. A 40-watt light held between the occupant of the chair and another person was lighted to full brilliancy. An oil torch could be lighted by bringing it near to a metal strip held in the assistant's mouth. The "electric kiss" was shown when a spark four or five inches in length jumped between a metal strip held in the mouth of the assistant in the chair, and a similar strip in the mouth of another.

An Oudin coil, 39 inches high was demonstrated in action, discharges nearly 4 feet in length being obtained. Another identical Oudin coil was placed some distance away, the primaries of the two resonators being connected in series. By proper tuning a discharge 6½ feet in length could be obtained between the secondary terminals. The two secondaries were then placed end on end on one of the primary bases, thus making a 6½ foot Oudin coil. When operating at full power the discharges from the terminal which was a large brass sphere were more than six feet in length, the voltage being over a million volts. The sparks quite often flashed over to the lighting fixtures near the ceiling. The noise was very great whenever this coil was in operation. The demonstrator again showed his ability to take high frequency discharges, even of this voltage, into his body. A brass rod with metallic handles was held in his hands to act as a terminal. A rather unpleasant sensation is experienced when receiving these powerful sparks since several amperes of current must be conducted over the surface and through the body, and there is a very noticeable tensing of the muscles of the arms, but no real pain is experienced. These sparks possess quite a dynamic force as may be shown when a small rotor formed of radial wires all bent at their outer ends circumferentially in the same sense or direction, is placed on the terminal and caused to rotate rapidly by the force of the discharges from the tips of the wires.

The "final act" and the one which gave the greatest thrills to the audience, was that in which the human body was used as the terminal of a four-foot Oudin resonator. This resonator had a secondary 6½ inches in diameter, being designed to give a very high frequency for a coil of this size. The terminal of the coil was connected to an aluminum plate 9 by 12 inches on which the demonstrator stood with bare feet, in order to obtain good contact. With thimbles on his fingers, long discharges flashed from the fingertips of his upraised hands. Thimbles were used to prevent cuticle burns on the fingers. The demonstrator then removed the thimbles and held a copper rod in his hand from which numerous sparks flashed. Two Geissler tubes, one held in each hand, were next lighted. The demonstrator then allowed the discharges to leave from the top of his head, a copper crown serving as the metallic terminal from which scores of sparks leaped into the air. The demonstrator then placed a short metal strip in his mouth, leaned his head back, and allowed a long heavy discharge to pass from his mouth in this manner.

These spectacular demonstrations are produced by apparatus which is relatively simple to build. Any experimenter could duplicate part or all of the experiments described with only a small outlay of capital, some work, and quite a bit of patience. The results so far obtained have been particularly satisfying, since the power transformer is only of 5 kilowatts rating, and the apparatus was built by students.

(To be continued)

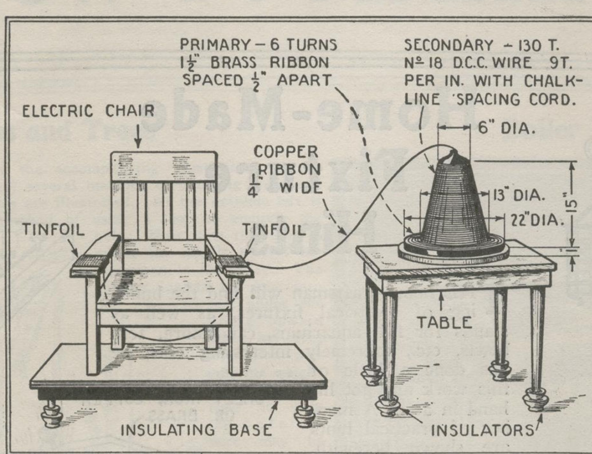
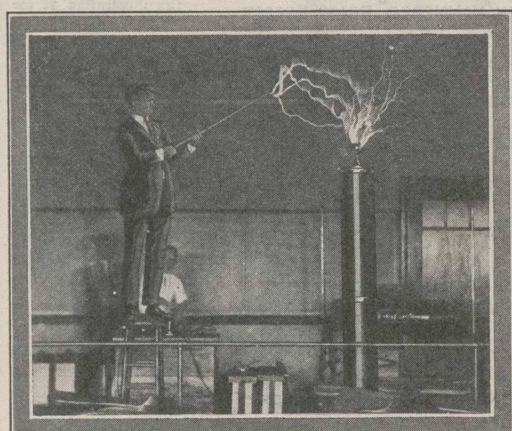
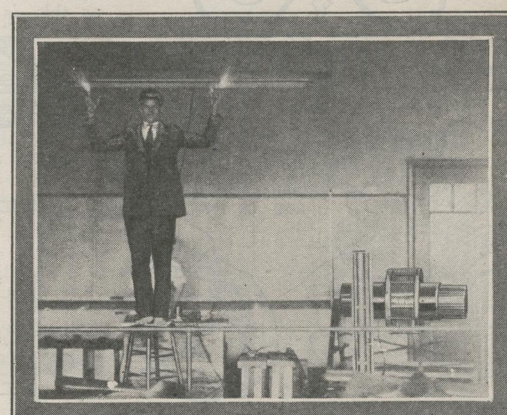


Diagram of the "Electric Chair"—a startingly suggestive demonstration of high-frequency discharges.



Left: A high voltage discharge passing from the 6½-foot Oudin coil to the brass rod held by the demonstrator.

Right: Electrical discharges passing from the finger-tips.

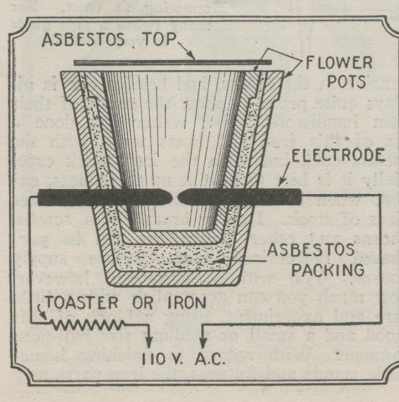


A Simple Electric Furnace

By Charles W. Fay

A SIMPLE but efficient electric furnace for experimental use may be easily constructed from two small flower pots of such size that one fits snugly within the other. The space between the pots is filled with shredded asbestos, and holes are drilled with an old drill of sufficient size to allow the carbon electrodes, which may be taken from an old "B" battery, to slip into the furnace easily, so that adjustments can be readily accomplished. If, however, the holes are too large, the electrodes will have so much play that adjusting the furnace will be extremely difficult. The diagram below will explain the construction. The furnace is connected to the service line with an electric toaster or flat iron in series with it.

It may be feared that the inner flower pot will succumb to the heat. This might occur if the experimenter pushed the heat for a long period. Undoubtedly a more permanent construction would result if Hessian or if clay crucibles were used instead of the flower pots. Plumbago crucibles would not answer as they are more or less good conductors of the electric current owing to the graphite mixed with their clay.



An effective arc furnace, made out of a couple of flower pots and some asbestos, with B-battery carbons as electrodes.

Another demonstration that gave the audience many thrills was that of the electric chair. This was an ordinary chair with metallic plates fastened on the arms. These plates were connected to the terminal of the conical Oudin coil. The chair was placed on the insulated base, and when operated eight- to ten-inch sparks leaped from the metal parts. After receiving no offers from members of the audience to sit in the chair, one of the assistants was used as the "victim." The person sitting in the chair felt no discomfort as long as the hands grasped the metal arm plates. A 40-watt light held between the occupant of the chair and another person was lighted to full brilliancy. An oil torch could be lighted by bringing it near to a metal strip held in the assistant's mouth. The "electric kiss" was shown when a spark four or five inches in length jumped between a metal strip held in the mouth of the assistant in the chair, and a similar strip in the mouth of another.

An Oudin coil, 39 inches high was demonstrated in action, discharges nearly 4 feet in length being obtained. Another identical Oudin coil was placed some distance away, the primaries of the two resonators being connected in series. By proper tuning a discharge 6½ feet in length could be obtained between the secondary terminals. The two secondaries were then placed end on end on one of the primary bases, thus making a 6½ foot Oudin coil. When operating at full power the discharges from the terminal which was a large brass sphere were more than six feet in length, the voltage being over a million volts. The sparks quite often flashed over to the lighting fixtures near the ceiling. The noise was very great whenever this coil was in operation. The demonstrator again showed his ability to take high frequency discharges, even of this voltage, into his body. A brass rod with metallic handles was held in his hands to act as a terminal. A rather unpleasant sensation is experienced when receiving these powerful sparks since several amperes of current must be conducted over the surface and through the body, and there is a very noticeable tensing of the muscles of the arms, but no real pain is experienced. These sparks possess quite a dynamic force as may be shown when a small rotor formed of radial wires all bent at their outer ends circumferentially in the same sense or direction, is placed on the terminal and caused to rotate rapidly by the force of the discharges from the tips of the wires.

The "final act" and the one which gave the greatest thrills to the audience, was that in which the human body was used as the terminal of a four-foot Oudin resonator. This resonator had a secondary 6½ inches in diameter, being designed to give a very high frequency for a coil of this size. The terminal of the coil was connected to an aluminum plate 9 by 12 inches on which the demonstrator stood with bare feet, in order to obtain good contact. With thimbles on his fingers, long discharges flashed from the fingertips of his upraised hands. Thimbles were used to prevent cuticle burns on the fingers. The demonstrator then removed the thimbles and held a copper rod in his hand from which numerous sparks flashed. Two Geissler tubes, one held in each hand, were next lighted. The demonstrator then allowed the discharges to leave from the top of his head, a copper crown serving as the metallic terminal from which scores of sparks leaped into the air. The demonstrator then placed a short metal strip in his mouth, leaned his head back, and allowed a long heavy discharge to pass from his mouth in this manner.

These spectacular demonstrations are produced by apparatus which is relatively simple to build. Any experimenter could duplicate part or all of the experiments described with only a small outlay of capital, some work, and quite a bit of patience. The results so far obtained have been particularly satisfying, since the power transformer is only of 5 kilowatts rating, and the apparatus was built by students.

(To be continued)

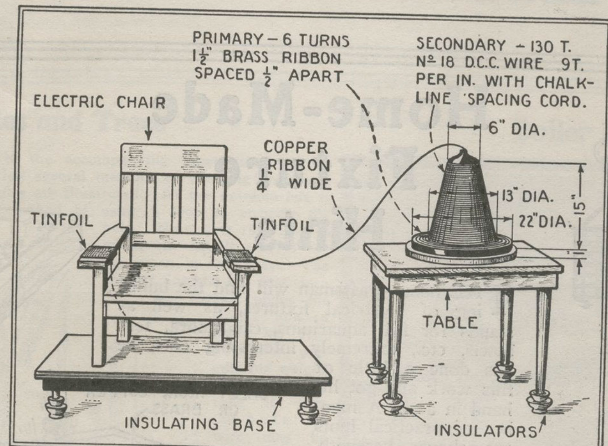
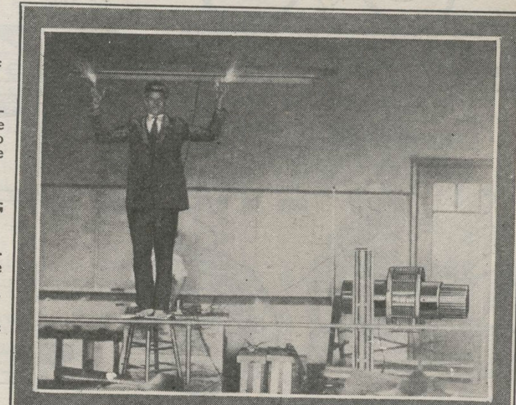


Diagram of the "Electric Chair"—a startingly suggestive demonstration of high-frequency discharges.

Left: A high voltage discharge passing from the 6½-foot Oudin coil to the brass rod held by the demonstrator.



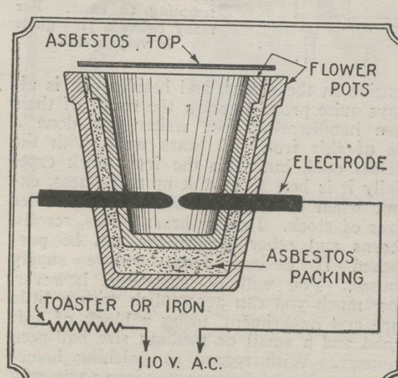
Right: Electrical discharges passing from the finger-tips.

A Simple Electric Furnace

By Charles W. Fay

A SIMPLE but efficient electric furnace for experimental use may be easily constructed from two small flower pots of such size that one fits snugly within the other. The space between the pots is filled with shredded asbestos, and holes are drilled with an old drill of sufficient size to allow the carbon electrodes, which may be taken from an old "B" battery, to slip into the furnace easily, so that adjustments can be readily accomplished. If, however, the holes are too large, the electrodes will have so much play that adjusting the furnace will be extremely difficult. The diagram below will explain the construction. The furnace is connected to the service line with an electric toaster or flat iron in series with it.

It may be feared that the inner flower pot will succumb to the heat. This might occur if the experimenter pushed the heat for a long period. Undoubtedly a more permanent construction would result if Hessian or if clay crucibles were used instead of the flower pots. Plumbago crucibles would not answer as they are more or less good conductors of the electric current owing to the graphite mixed with their clay.



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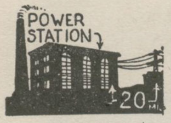
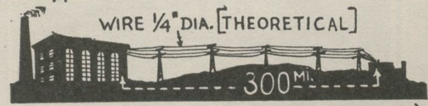
Why High Voltage is Desired

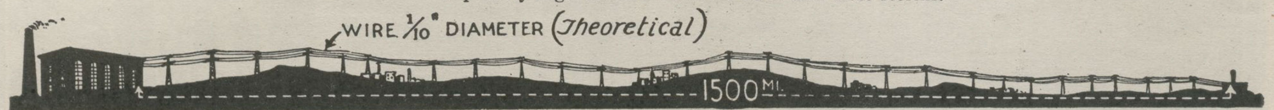


LOW VOLTAGE 500 TO 2000 VTS. D.C. OR A.C. TRANSMISSION, GOOD FOR 10 TO 20 MILES. WIRE 1¾" DIAMETER



PRESENT HIGH VOLTAGE A.C. (220,000 VOLTS) POWER TRANSMISSION

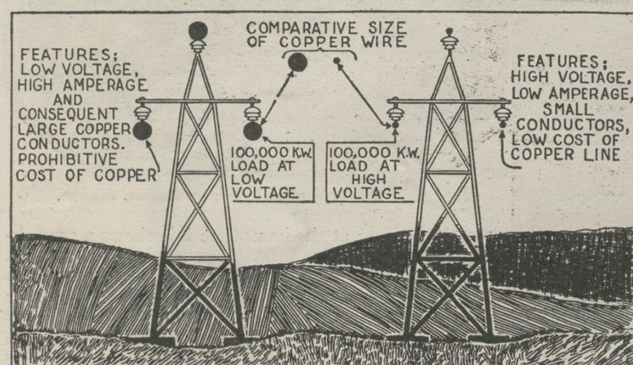
ONE of the principal objects that electrical engineers have in mind in the development of such high voltage testing laboratories as that illustrated on the opposite page, is the gradual lengthening of the circuits over which electrical energy may be transmitted efficiently. A glance at the three accompanying picture diagrams shows where we stand today and what the future may bring forth, when our engineers are able to adapt potentials of one and one-half million to two million volts to our transmission line problems. The corona or stray leakage loss along high voltage tranmission lines becomes excessive when the potential is increased much above 250,000 volts, as the diagrams below show. Another problem which high voltage, once it is harnessed to transmission lines will solve, is the reduction of the size of the copper wire, the diameter of which decreases as the voltage increases, with the same load in each case. In other words to transmit 10,000 kilowatts, the engineer who uses the highest voltage possiible will build the cheapest transmission line, as the three diagrams herewith clearly indicate. In the third example of 1500 miles transmission with 2,000,000 volts, a wire the size of the lead in a pencil could be used theoretically, but to stand mechanical and wind stresses it will have to be about three-eighths inch in diameter. With greater knowledge of high tension currents, our engineers in the next few years will doubtless be able to place high voltage transmission lines underground instead of on towers exposed to the weather, especially high winds as well as snow and sleet storms.



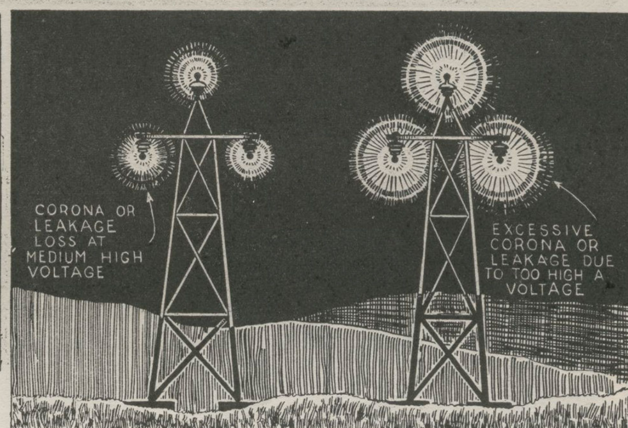
FUTURE HIGH TENSION A.C. (1,500,000 TO 2,000,000 VOLTS) POWER TRANSMISSION

FUTURE USEFUL POWER 1500 MILES FROM CENTRAL STATION.

The three diagrams above show the great difference in diameter of copper wire necessary for low voltage transmission, compared with the present high voltage (220,000 volts) transmission, and what we may expect in the future when 2,000,000-volt power transmission over 1500 miles or more, may become a reality instead of a dream. The main thing that keeps the voltage down is the high corona loss.

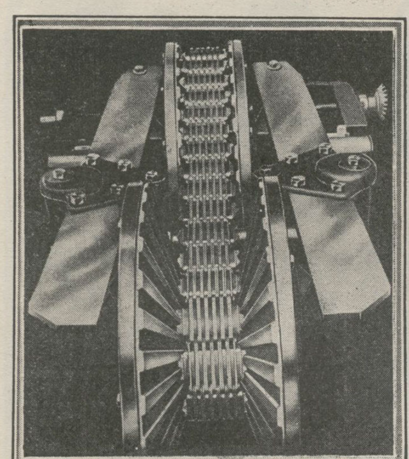


In the picture diagram above one can see at a glance why it is that to transmit 100,000 kilowatts, engineers would rather use 100,000 volts for example, than they would 10,000 volts. The size of the copper wire decreases as the potential increases, with the same amount of power to be transmitted. Heavy steel towers have to be used to support large copper conductors, which is also a big consideration on a fifty to seventy-five mile long transmission line.

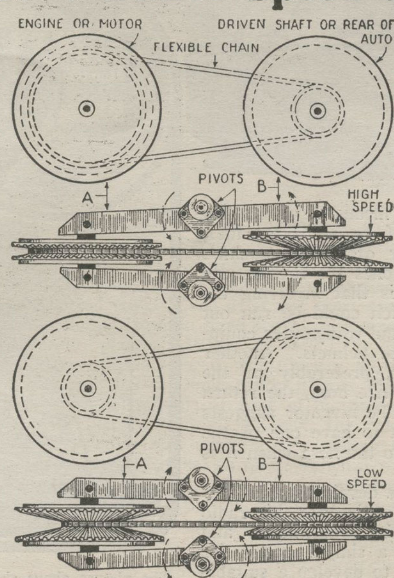


Here we see what happens when the voltage of a transmission line is increased to a certain degree. When the corona or stray electrical discharge exceeds a certain amount, the line losses become prohibitive.

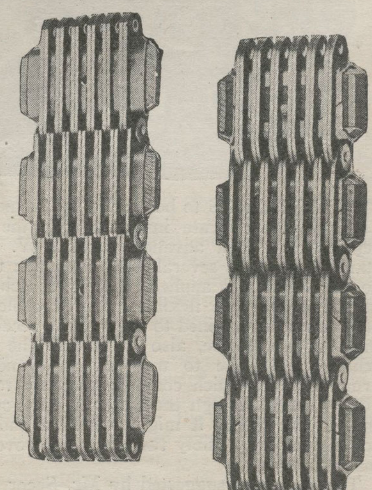
Gearless Variable Speed at Last



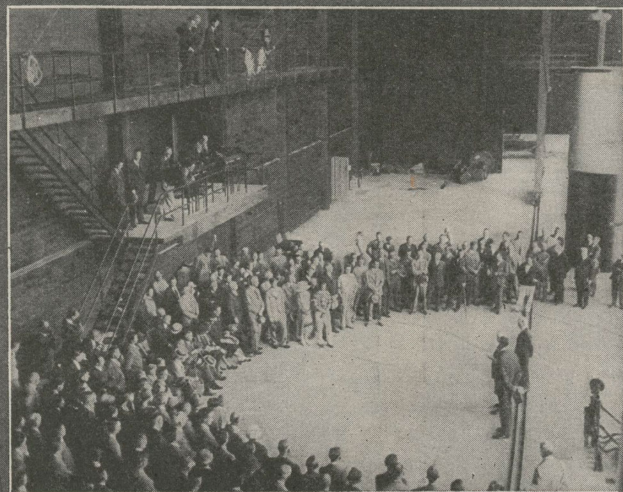
A positive drive, infinitely variable gear which has been sought for many years, was recently exhibited in England at a mechanical exhibition. This change speed transmission known as the P. I. V. device is capable of an almost infinite number of speed changes between the driver and driven shafts. It should mark a step forward for automobile purposes.



The two diagrams above show how levers open and close grooved cones and change speeds.



The two photos above show appearance of chain connecting the two sets of variable cone pulleys used in the P. I. V. gear box. With a single lever, innumerable speeds are at one's instant command. It should prove welcome in motor cars instead of the present awkward gear box.



2,000,000 Volts Turned Loose!

A SHORT time ago at the Harris J. Ryan high voltage laboratory of Leland Stanford University, California, there was produced tremendous electrical discharges, as shown in the accompanying pictures, when electrical potentials as high as 2,000,000 volts were turned loose. The purpose of this high voltage laboratory is to test various electrical apparatus, particularly the insulators used on high voltage transmission lines in order to determine accurately the reasons why these insulators break down at high potentials and various other phenomena connected with high tension line operation.

The picture at the left shows the opening exercises at the Harris J. Ryan high voltage laboratory at Leland Stanford University, with Dr. Ray Lyman Wilbur, President of the University, explaining the objects and purposes of the new high voltage laboratory to the engineers and scientists present. This was followed by demonstrations.

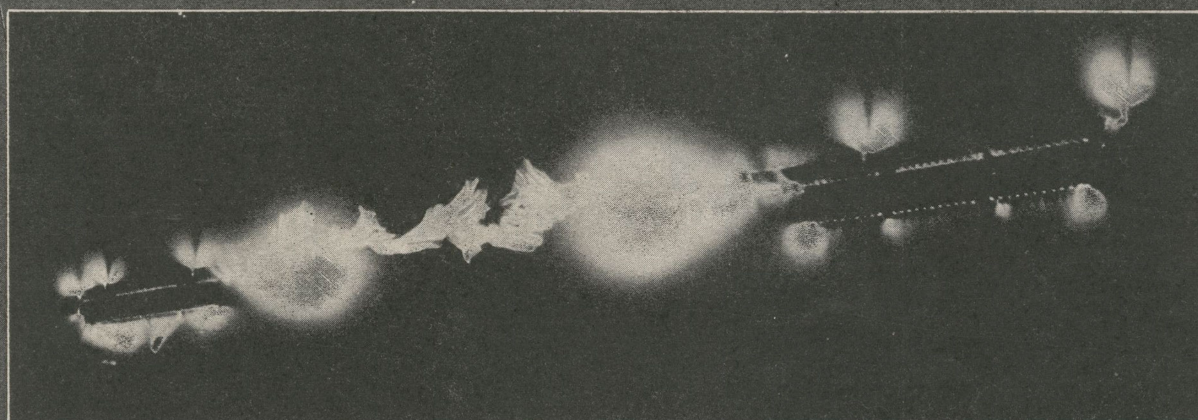
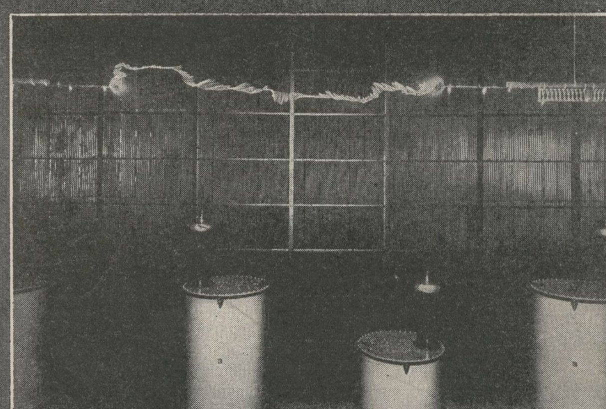
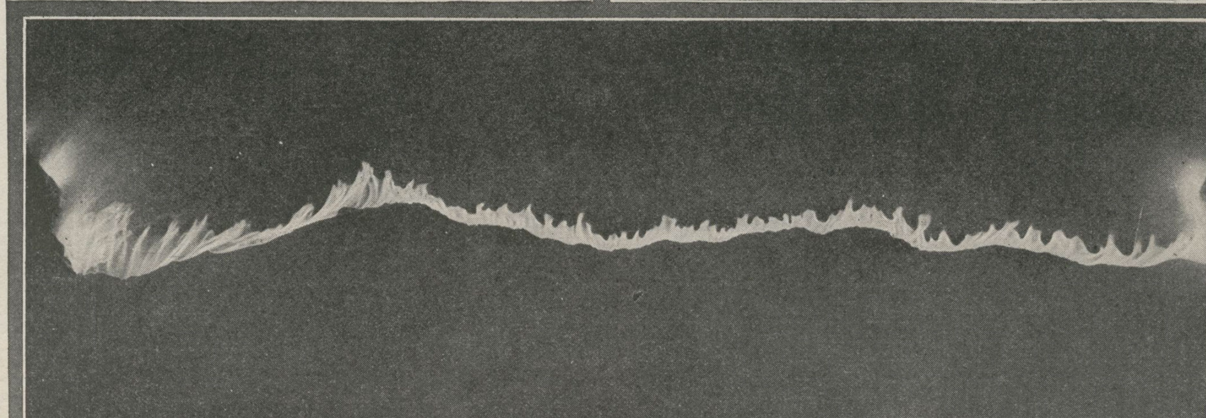


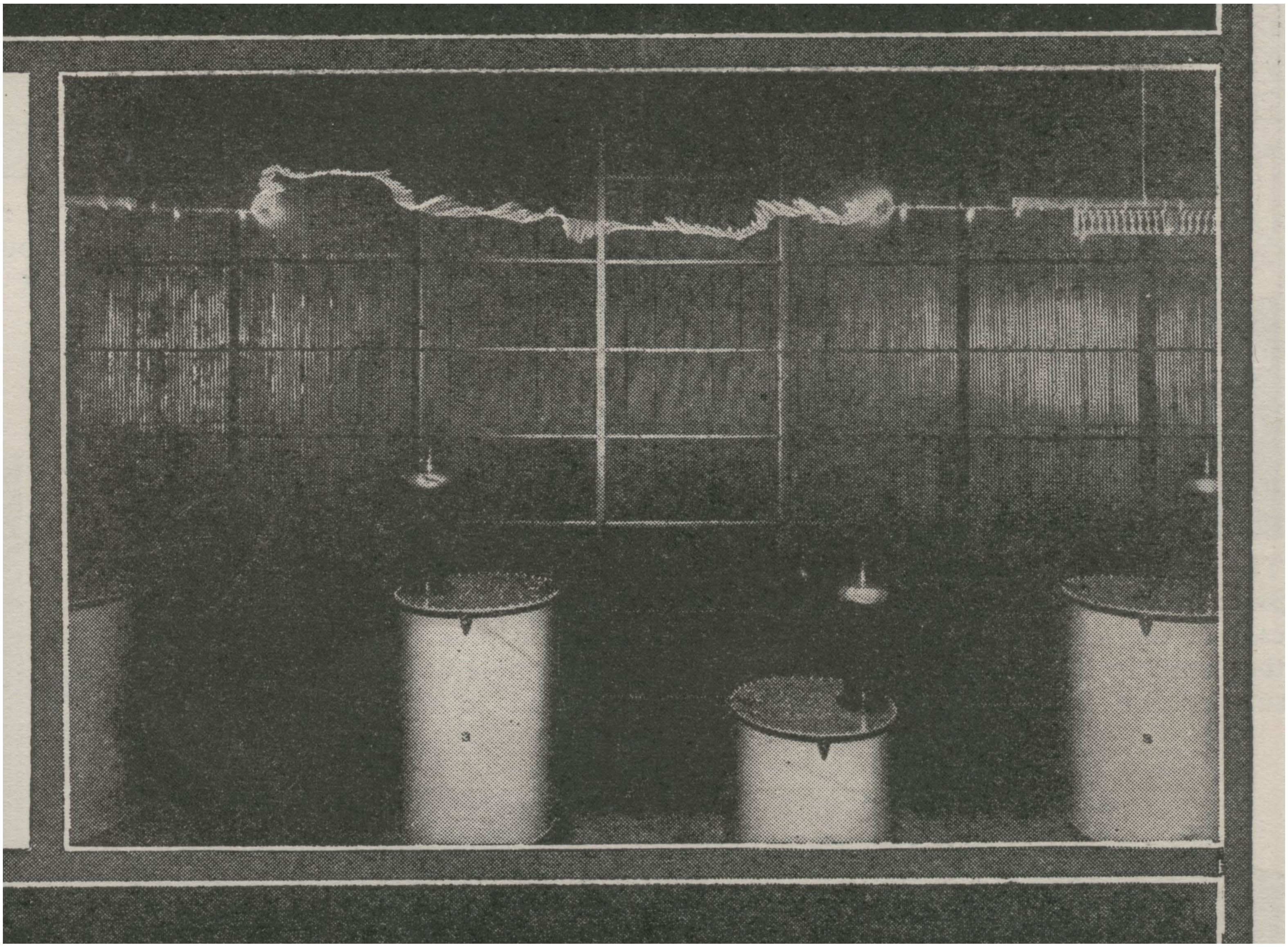
Photo above shows beautiful ribbon-like discharge of 2,100,000 volts. The discharge jumped a twenty-foot gap in many cases. The tests of the apparatus were conducted in total darkness. At first faint sparks are seen to emerge from the electrodes forming eventually a corona. It is this corona or fine web of sparks seen to exist about the wires and electrodes in the dark, that spells wasted power to the designers of long distance high voltage transmission.

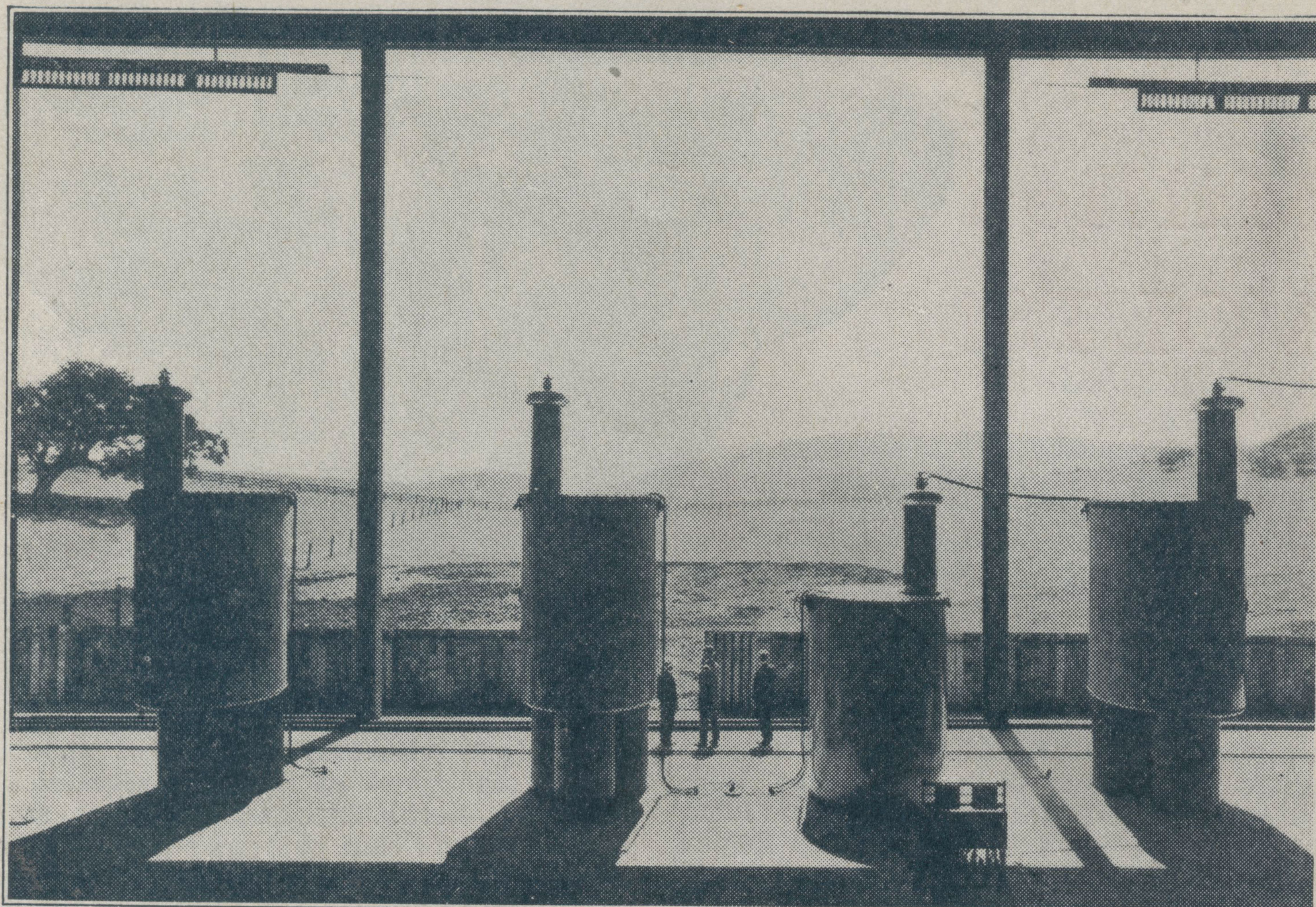
Picture at right shows 2,100,000 volt discharge taking place, and below it four of the six 350,000 volt transformers which were connected in series to give the 2,100,000 volt discharge. Each transformer was insulated from the ground by supporting it on an insulating cylinder. The steel building housing the transformers is 173 ft. long, 65 ft. high and 60 ft. wide. The building is lightproof and will enable scientists to study visually the corona phenomena.

Another picture of the 20 ft. discharge at 2,100,000 volts is shown below and this represents one of the highest potentials ever produced by man. Among the objects of these high voltage tests are the development of better insulators, reduction of line losses and the improved designs of high voltage transformers. Mathematical design cannot be trusted alone in this high voltage work, but should be supplemented by actual laboratory tests, which have now become possible.







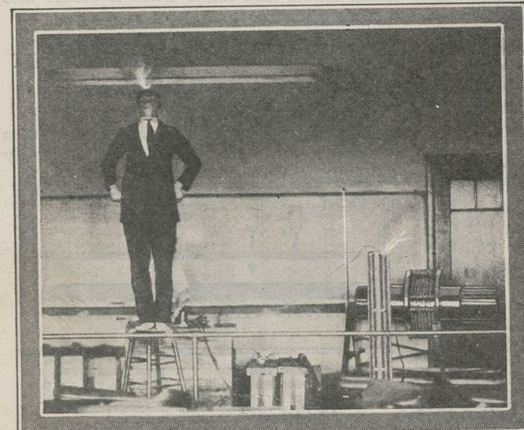


Looking From the Laboratory Showing [illegible]

Interesting Experiments with High Frequency Currents

By S. E. NEWHOUSE, JR.

EVER since the earliest time, man has looked with awe upon nature's marvelous electrical demonstrations in the form of lightning. It remained for Benjamin Franklin to be the first to attempt to learn something of the science connected with this remarkable manifestation of electrical energy. His well-known experiment with a kite in the eighteenth century marked the beginning of high voltage and high frequency experimentation. Since then man has made great strides in this field of electrical science. Such men as Tesla and Steinmetz have given us valuable information concerning the scientific nature of lightning.



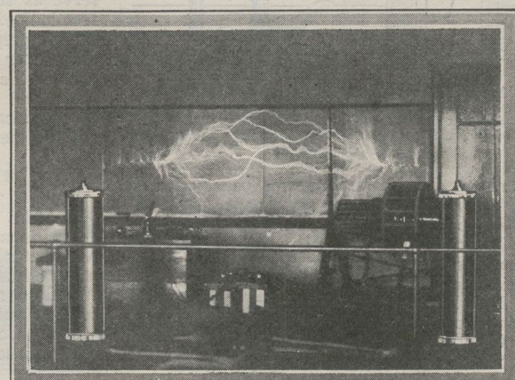
With his body charged to a potential of 500,000 volts, the demonstrator appears super-human when long sparks leap from a metal strip held in his mouth.

The trend of modern electrical work is toward higher potentials; 220,000-volt lines have been put into successful operation, and even higher transmission voltages are being contemplated. Science must always keep a few years ahead of commercial progress, and for this reason many high voltage laboratories are at work making tests to determine what may be expected of future equipment. But there is much to be learned of the nature of lightning, which is a serious problem in high voltage transmission. High frequency currents which are of an oscillatory nature, as is lightning, have real practical application in this field of research, as it is quite common in practice to use high frequency currents in the commercial tests on insulators. The field of electro-therapeutics has made extensive use of these oscillatory currents in the X-ray and violet ray machines. High frequency furnaces are being built.

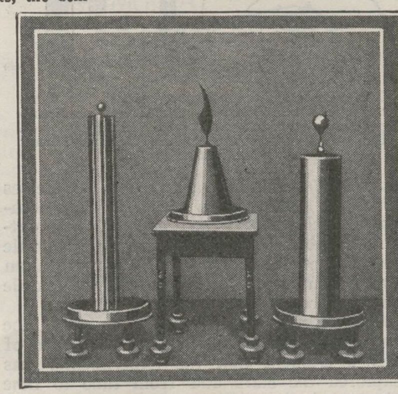
Here at Washington University, we have one of the best equipped high frequency laboratories in any school in the country. The feature exhibit of the annual Engineers' Day held each spring, is the high frequency demonstration. During the course of the day seven or eight complete demonstrations are given. These demonstrations consist of a large number of electrical "stunts" in which high frequency currents are used.

The "opening number" on the program is the demonstration of the four-foot Tesla coil, which gives a discharge of 54 inches in length, between its secondary terminals. This is followed by an exhibition of the seven-foot Tesla coil which gives a secondary voltage of more than 1,000,000 volts, the spark being nearly seven feet in length. A very startling and vivid effect is accomplished in all of these experiments by giving the demonstrations in a darkened room. The consrtuction of the apparatus used will be described later.

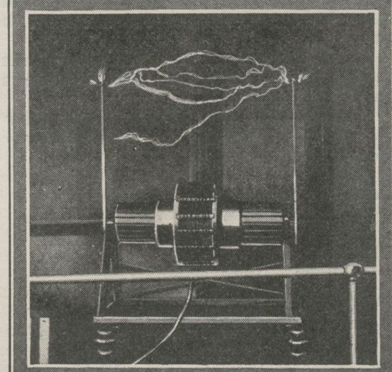
Two high frequency electric signs are exhibited. On one sign a large butterfly is shown in a brilliant corona discharge, and on the other are the words "Washington University," likewise illuminated. This effect is obtained by pasting tinfoil on both sides of a pane of glass. The desired design is cut out of the tinfoil on one side and the two metallic sheets are connected across the terminals of the condenser to be shown in circuit diagram. The edges of the tinfoil give a corona discharge as do the plates of the condenser.



A discharge of 1,000,000 volts between two 39-inch Oudin resonators.



High frequency resonators (left to right): 4-foot Oudin coil, a conical Oudin coil, and a 39-inch Oudin coil.



The four-foot Tesla coil in full discharge.

A large variety of Oudin coils have been built for the laboratory, and the demonstration of a number of these constituted the major portion of the performance. Oudin coils differ from Tesla coils in that one end of the secondary is connected to the primary and the discharge takes place from the free end of the secondary which usually terminates in a brass sphere; while in a Tesla coil the discharge takes place between the two secondary terminals, neither of which are connected to the primary.

A conical shaped Oudin coil was shown in operation; the discharge from the terminal resembling tongues of flame or writhing serpents. This coil is 15 inches high and gives a discharge nearly two feet in length in all directions from the terminal. The demonstrator showed how easily these discharges could be taken into the body, first with a copper strip held in the hand, and then with a metal strip held in the mouth. It is quite essential that the discharges should not enter or leave the body on the bare skin for a rather bad burn might result. The author has had a number of unpleasant experiences in this work. It is also very advisable for the demonstrator to stand on an insulated base while receiving the discharges. A heavy marble slab 20 inches by 50 inches laid in a wooden frame supported by four petticoat porcelain insulators was used for this purpose.

Another of the smaller type Oudin coils, when slightly de-tuned gave a beautiful fountain-like discharge of purple mist between the primary and the secondary. With any of the apparatus in operation, it was possible to light up Geissler tubes in the vicinity of the discharging coil. These were evacuated glass tubes about three feet in length, with a small tinfoil covering at each end. The various degrees of evacuation give a variety of colors of light within the different tubes, and very pretty effects are to be obtained.

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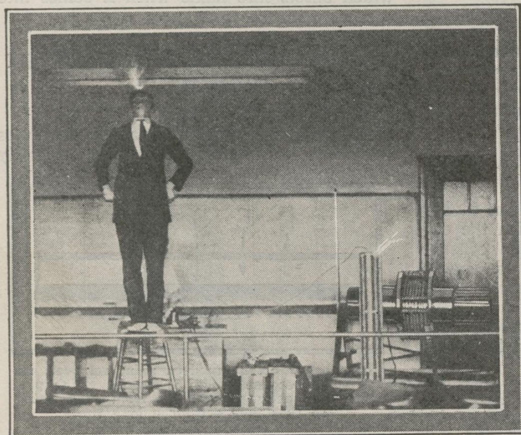

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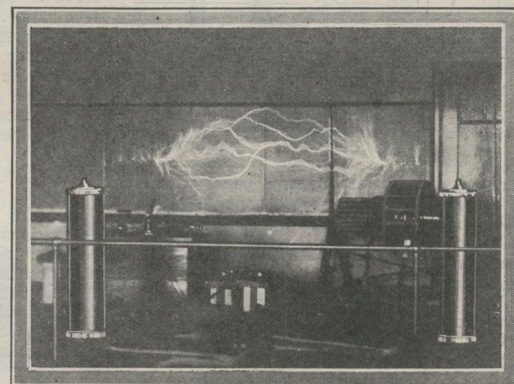

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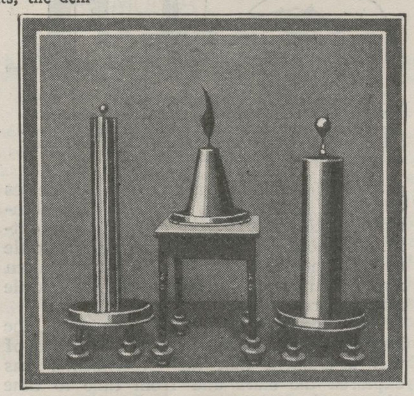

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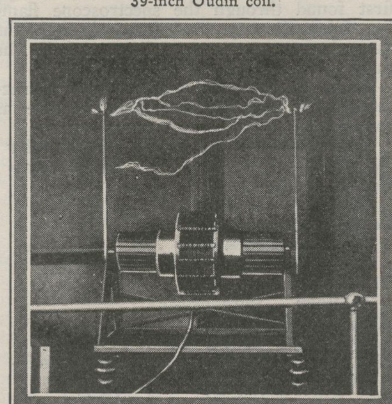

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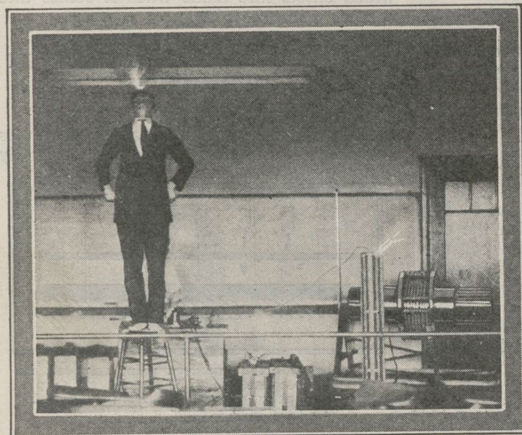

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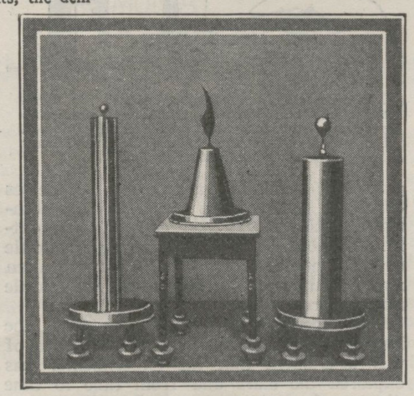
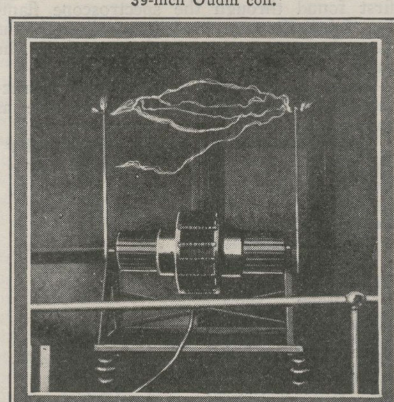
Here at Washington University, we have one of the best equipped high frequency laboratories in any school in the country. The feature exhibit of the annual Engineers' Day held each spring, is the high frequency demonstration. During the course of the day seven or eight complete demonstrations are given. These demonstrations consist of a large number of electrical "stunts" in which high frequency currents are used.

The "opening number" on the program is the demonstration of the four-foot Tesla coil, which gives a discharge of 54 inches in length, between its secondary terminals. This is followed by an exhibition of the seven-foot Tesla coil which gives a secondary voltage of more than 1,000,000 volts, the spark being nearly seven feet in length. A very startling and vivid effect is accomplished in all of these experiments by giving the demonstrations in a darkened room. The consrtuction of the apparatus used will be described later.

Two high frequency electric signs are exhibited. On one sign a large butterfly is shown in a brilliant corona discharge, and on the other are the words "Washington University," likewise illuminated. This effect is obtained by pasting tinfoil on both sides of a pane of glass. The desired design is cut out of the tinfoil on one side and the two metallic sheets are connected across the terminals of the condenser to be shown in circuit diagram. The edges of the tinfoil give a corona discharge as do the plates of the condenser.

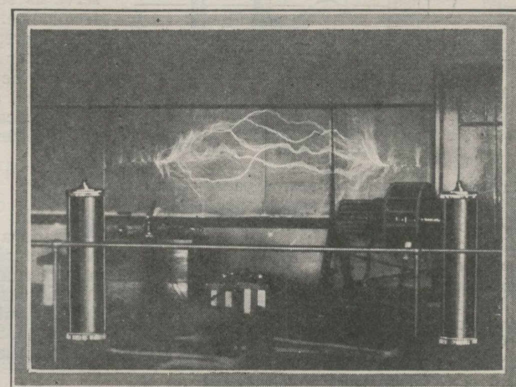


High frequency resonators (left to right): 4-foot Oudin coil, a conical Oudin coil, and a 39-inch Oudin coil.



The four-foot Tesla coil in full discharge.

A large variety of Oudin coils have been built for the laboratory, and the demonstration of a number of these constituted the major portion of the performance. Oudin coils differ from Tesla coils in that one end of the secondary is connected to the primary and the discharge takes place from the free end of the secondary which usually terminates in a brass sphere; while in a Tesla coil the discharge takes place between the two secondary terminals, neither of which are connected to the primary.



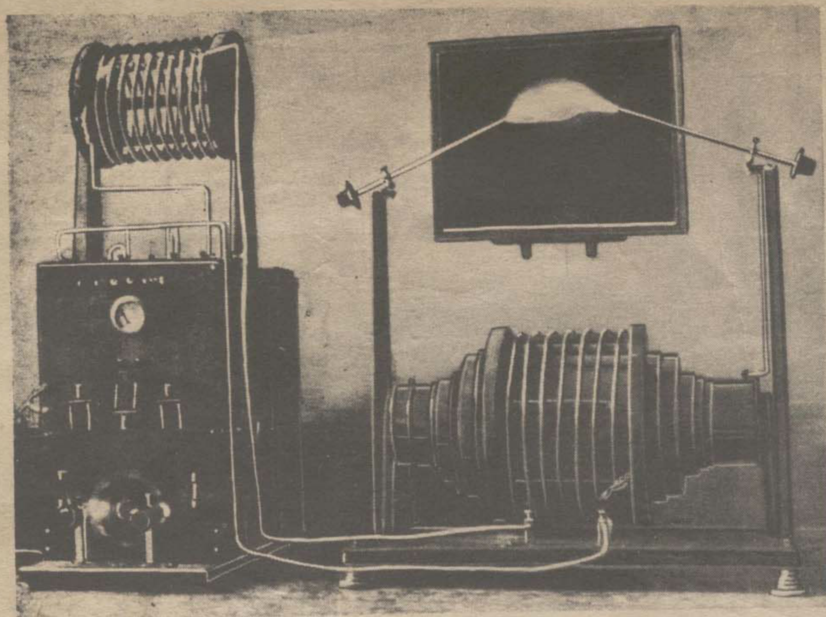
A discharge of 1,000,000 volts between two 39-inch Oudin resonators.

A conical shaped Oudin coil was shown in operation; the discharge from the terminal resembling tongues of flame or writhing serpents. This coil is 15 inches high and gives a discharge nearly two feet in length in all directions from the terminal. The demonstrator showed how easily these discharges could be taken into the body, first with a copper strip held in the hand, and then with a metal strip held in the mouth. It is quite essential that the discharges should not enter or leave the body on the bare skin for a rather bad burn might result. The author has had a number of unpleasant experiences in this work. It is also very advisable for the demonstrator to stand on an insulated base while receiving the discharges. A heavy marble slab 20 inches by 50 inches laid in a wooden frame supported by four petticoat porcelain insulators was used for this purpose.

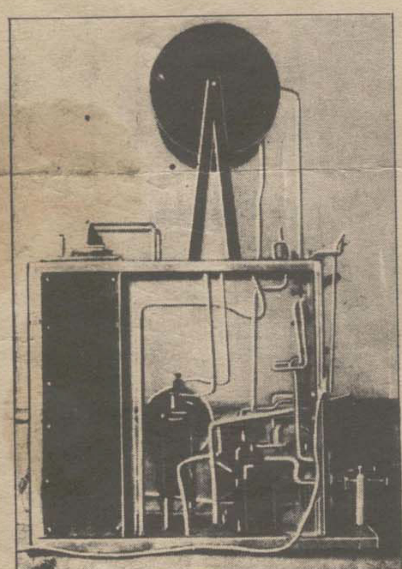
Another of the smaller type Oudin coils, when slightly de-tuned gave a beautiful fountain-like discharge of purple mist between the primary and the secondary. With any of the apparatus in operation, it was possible to light up Geissler tubes in the vicinity of the discharging coil. These were evacuated glass tubes about three feet in length, with a small tinfoil covering at each end. The various degrees of evacuation give a variety of colors of light within the different tubes, and very pretty effects are to be obtained.

High-

Building an Oudin coil, a Tesla coil, and how to construct a control board for the same, containing all equipment needed for proper operation



A nine-inch spark from the Tesla, the construction of which is described; input, ¼-K.W. transformer.



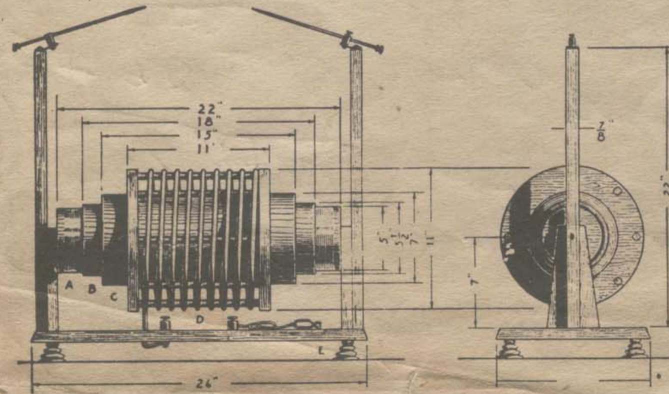
Side view, showing the location of most of the apparatus.

● IN the following article is given a complete description for the making of high-frequency apparatus which, with an input from a ¼-K. W. transformer having an 8,000-volt secondary, will produce a spark 9 inches long from the secondary of the Tesla coil, and with a ½-K. W. transformer (such as may be obtained from a neon lighting outfit) having a secondary with four taps of 5,000, 8,000, 12,000 and 15,000 volts, will deliver an 18-inch spark.

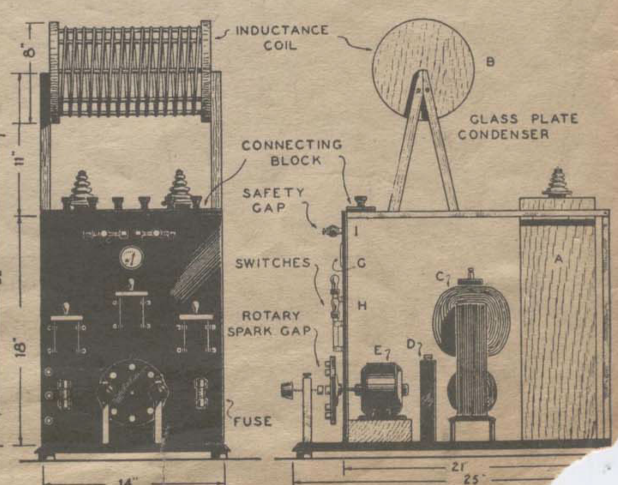
With such a coil, all the familiar Tesla experiments can be carried out and the gas X-ray tubes can be made to operate.

The current from the Oudin coil is absolutely harmless and may be taken into the body, even though the voltage may be in the neighborhood of 500,000 volts; the frequency is so high that the current does not penetrate deeply, but merely runs along the skin surface. It is always advisable, when passing the spark through the body, that a small piece of metal, such as a metal rod, be clasped in the hand, and that this be approached to the ball on top of the Oudin; otherwise the heat of the spark may produce a "shock" sensation. It is also always advisable, when operating the Oudin, to connect the ground lead to a suitable ground and so protect transformer windings. For further protection of line wires and meter, a kick-back preventer has already been wired into the circuit.

The control board for the high-frequency apparatus permits connecting either the Oudin coil or Tesla coil to the same; and it confines the necessary material for excitation of the coils into one compact place, instead of having them scattered all over the table. The connections go directly to a connecting block. The baseboard of the control equipment is a piece of hardwood (formerly an old table top), which was cut to 14½"x25" and beveled; then four rubber feet were set under the bottom. A piece of ¼" veneer from an



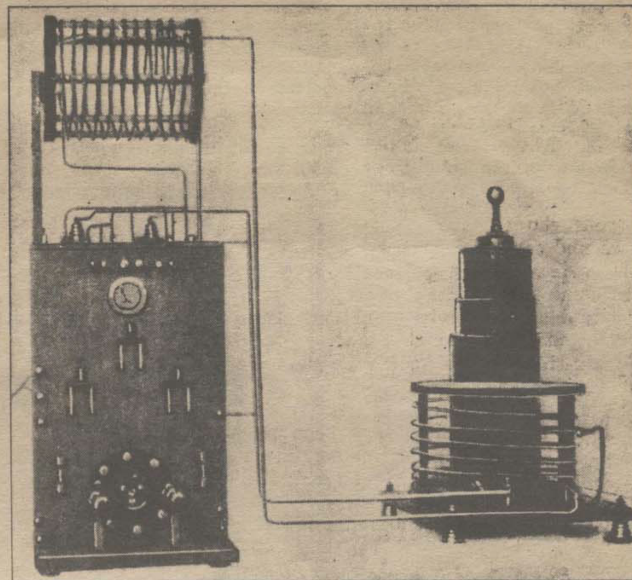
Front and side view of the Tesla coil, giving all of the dimensions; from which the construction may readily be duplicated by even the novice.



Front and side view of the control-cabinet layout.

Frequency Apparatus

by Ludwig Depose



How the Oudin coil is connected to the control board.

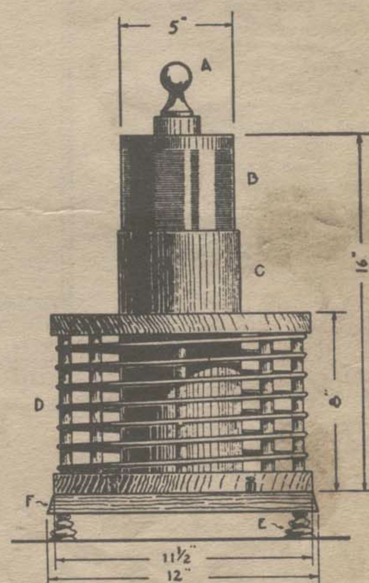
oid closet door was cut to 14"x18" for the panel, and given two coats of varnish; then bracketed to the base. The 150-volt A. C. voltmeter is optional and need not be added.

While a fan motor can be used to operate the rotary spark gap, in this construction a vacuum cleaner motor was employed. The rotor of the rotary spark gap is cut from a sheet of bakelite and is 5" in diameter; eight holes are drilled for the contacts, which are of zinc, made from a zinc rod ½" in diameter. One side of each piece is drilled and tapped for an 8/32 screw. The zinc contacts are then fastened to the disc of bakelite with round 8/32 screws, and a piece of wire is soldered to each connecting all the contacts together. For the other side of the rotary gap, two square rods ½"x½"x5" long were drilled through the side 1" from the top and tapped to pass an 8/32 brass screw, 4" long. A zinc contact is crewed to one end of the 4" screw, and the other end is fitted with a hard rubber binding post. The square rods are mounted vertically in front of the disc (directly in line with the contacts) to two pieces of zinc, and these zinc strips in turn are connected to two wires which pass through the board. The disc itself is fastened to a pulley which in turn is fixed to the motor shaft with the set screw.

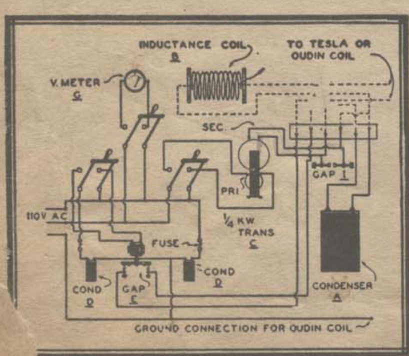
The safety gap consists of two brass binding posts, two 8/32 screws 3" long (with the heads cut off), two zinc contacts made as described before and two hard-rubber binding posts. The space, when the gap is set for a ¼-K. W. transformer, is ⅝". The three switches found on the panel were taken from their porcelain bases and for fuses, two 30-ampere cartridges were employed, clips for the same also being removed from the porcelain bases.

The inductance coil was built up on circular pieces of wood ⅞" thick, 8" in diameter. Eight holes were drilled halfway through each piece to receive ⅝" dowels, which were set into place with waterproof glue. The dowels were marked by first winding a piece of string around them, then notching with a rat-tail file; they were wound with ¼" soft-copper tubing, pulled tightly so that it cannot slip out of the spacing notches. A small battery clip is fastened to a 12" length of flexible copper wire, to change the inductance by altering the number of turns in the circuit. For a kick-back preventer, two ordinary telephone condensers, with capacity of 2 mf. each, are connected in series across the line, and the center point is connected to the ground.

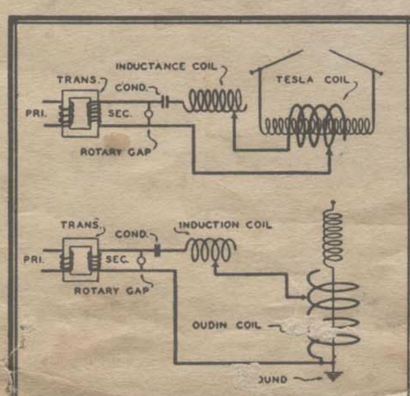
The connecting block is a piece of bakelite 14"x3" containing six binding posts; this is fastened on the top front end of the frame with brass angles. For the large condenser, 18 glass plates 9½"x14½"x1/16" are acquired, and 17 copper sheets, 24 gauge, cut to the size indicated. Both sides of the glass plates are cov-



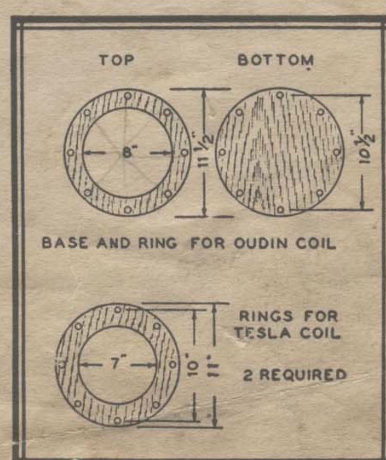
Measurements of the Oudin coil.



...ial circuit diagram, mak... it easy for the ...tus to be connected together, if the sym- ...epresentations for the various parts are not understood.



Circuit diagram for Oudin and Tesla connections.



Dimensions of the end rings for the primaries.

ered with varnish, and the copper sheets are put in between with the lugs brought out alternately; first to the right, then to the left. The lugs may be soldered together and are then connected by means of a small piece of wire with posts in the top of two stand-off insulators, fastened to the top of the condenser case. A ½" space is left all around the plates, in the building of this case, and the space is filled with melted beeswax.

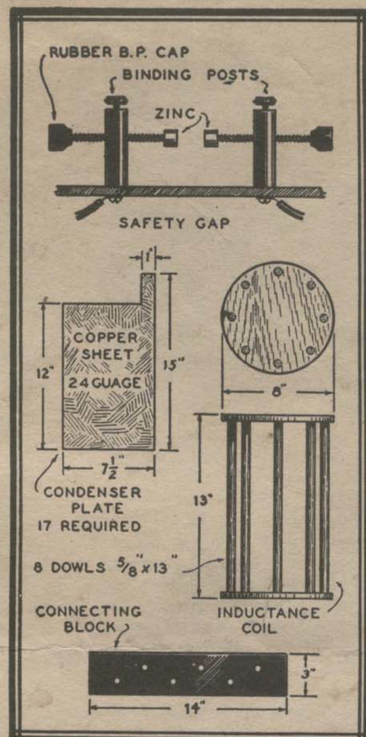
The uprights holding the inductance coil are four pieces of wood ⅞"x⅞"x11" long. They form an inverted V and are fastened to the center of the circular pieces, preferably with dowels; although wood-screws could be used in this position.

The base of the Oudin coil was cut from the same table top and measures 12"x14". Two binding posts are mounted on the front. The primary consists of ¼" copper tubing, wound on a drum of the dimensions given in the diagram.

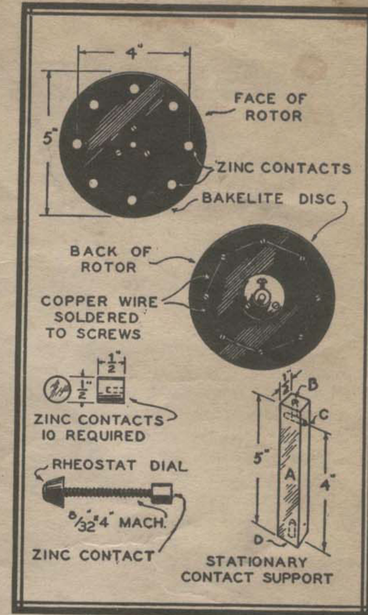
Here again, ⅝" holes are drilled to take the vertical dowels. The secondary is a bakelite tube ⅝" in diameter, although a pasteboard mailing tube could be used after being treated with two or three coats of shellac. No. 30 double-cotton-covered wire was used in winding the secondary, and a string of the same diameter was wound on at the same time, in this way, separating the wire by its own thickness. The winding was done by hand, one person rotating the cylinder while another did the winding. In order to keep the wire in place, the top was given a coat of varnish first and, when it was tacky, the winding was started. After the coil was completely wound, the string between the turns was removed and the coil was given three coats of varnish. The bottom of the tube was fitted with a round block, fastened on the inside, and a hole was then drilled through this to pass the wire connection which attaches to the left binding post. A clip is connected to the right post.

Details for construction of inductance coils, copper sheets for condenser, and safety gap.

In the top of the secondary tube another block was fastened, another long machine screw passed through it. The wire from the top of the secondary is connected to the brass ball, (obtained from an old ornamental iron gate or a bed post). Four stand-off insulators were fastened to the bottom of the base. The secondary is covered with a heavy insulating paper layer ¼" thick, although heavy wrapping paper may be substituted, if given a coat of varnish first.



The construction of the Tesla coil follows in general the construction of the Oudin coil. It will, however, be seen that the primary is in the center; that it does not connect with the secondary; and that two rods ¼" thick, filed to a point form the spark gap. The wire on the secondary is the same as in the Oudin, and is space-wound in the same way.

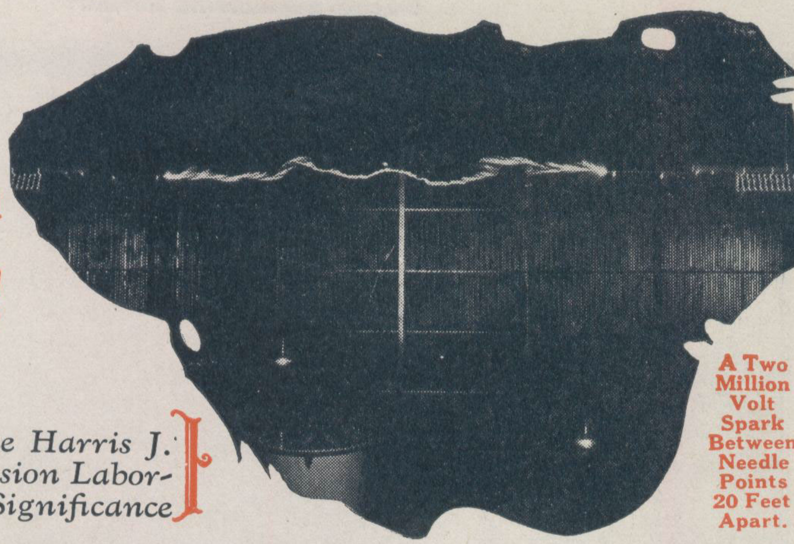


Details for rotary spark gap.

It should be remembered by the builder that, wherever possible, wooden dowels should be used in the construction, particularly for fastening the round discs of wood into the secondaries of the coils and that, wherever possible, no metal parts should enter the construction other than those distinctly specified. In this way, it will be made quite unlikely that a spark will fly from the secondary to any of metal screws or other pieces; and all the current will be effective at the gap. It is also advisable to give the article at least three coats of varnish after it is finished, wood and all, but not over the primary copper tube.

13" Long 8" in Dia

2 Million VOLTS!



A Two Million Volt Spark Between Needle Points 20 Feet Apart.

The Story of the Harris J. Ryan High Tension Laboratory and its Significance

THE highest voltage yet obtained by man was recently demonstrated in the new laboratory of Stanford University, California, before an assemblage of eminent men of science, educators, and the press. A ribbon of living flame, more than 20 feet long, leaped between two points high in the air above six giant transformers, marking the highest voltage yet attained at commercial frequency — 2,100,000 volts.

With this new equipment experiments will be carried on under the direction of Professor Harris J. Ryan of the electrical engineering department of the University, and his assistants, to determine the necessary facts for engineers to design equipment to handle the voltages which will be needed in the near future. Electrical power in the far west — where 60 per cent of the nation's water power is to be found—will have to be carried over long distances from its sources in the waters of the mountains to the markets in cities and valleys hundreds of miles away, making high voltage a necessity.

The new laboratory is an immense structure with a steel framework covered with asbestos. The main building is 173 feet long, 60 feet wide, and 65 feet high. It has an interior height of 50 feet in the clear to the roof trusses, with no supporting columns.

Laboratory Can be Made Light-proof

For some experiments the building can be made light-proof, not a ray of sunshine penetrating to its vast interior. For other uses, practically one whole side can be rolled away, utilizing 3 doors that are the largest ever constructed.

The reason for these giant doors and for the great space within the building lies in the fact that safety for life and equipment requires that there be a full 20-foot clearance everywhere about the main electrodes.

The six transformers are of special design, the work of Allen B. Hendricks of the General Electric Company, and were built by that company at its Pittsfield, Mass., works. Each unit is rated at 350,000 volts high tension, 2300 volts low tension, and weighs 22 tons.

Star Connection Provides Higher Voltage

For three-phase operation the six transformers are connected in three groups, each consisting of two transformers in series. The three groups are connected in Y and the neutral grounded. This gives 700,000 volts between each terminal and neutral, and 1,200,000 volts three-phase between terminals.

Various other combinations using from one to six transformers may also be obtained.

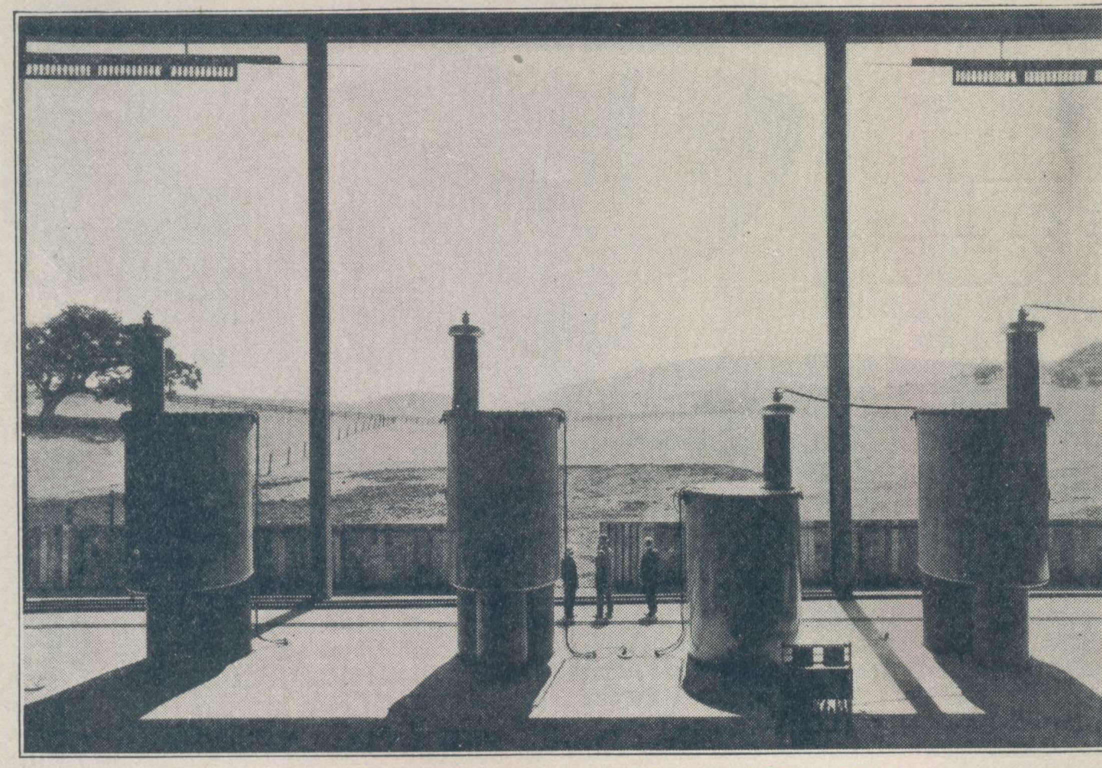
Each transformer is supplied with a voltmeter coil. At full rated load, 350 kv-a is required for each transformer, or 2100 kv-a when all six transformers are in use.

200 Acres Devoted to Electrical Laboratory

For measuring the high tension voltage there is provided a spark-gap consisting of 1000 mm. sphere.

Stanford University has appropriated from its widespread campus lands a strip 100 yards wide and a mile and a quarter long for a right of way for an experimental high voltage transmission line, and has reserved additional land to make possible a right of way seven miles long when it is needed. All told, the university is devoting about 200 acres of its land to the laboratory.

Such studies and tests as those which Professor Ryan and his assistants will



Looking From the Laboratory Showing Needle Pcints at Top of Laboratory and Four of the Six Transformers.

carry on in the new laboratory are vitally essential to the growth and continued prosperity of the Far West.

Commenting on the work to be done in the laboratory, Dr. Ryan has pointed out its significance in these words:

"Sixty per cent of the available water power of the United States is located on the Pacific coast and the adjacent back country. The sources of these corresponding water powers generally occur at the highest elevations, often 100 to 200 miles or more from their corresponding market centers.

"It is a reasonable assumption that by 1935 all of the water powers that are within economic reach of the bay region will have been developed and put to use, employing a transmission voltage of 220,000.

High Voltage Necessary to Pacific Power Development

"Such undertakings can only be realized through interconnection of all great powers and markets generally throughout the Far West. These interconnections will require far greater transmission distances than those heretofore accomplished.

"The progress of the Far West is extraordinary and has been made possible only through economic power and communication. If such progress is not to be greatly reduced after ten years, adequate corresponding advances must be made in the technical knowledge of the high voltage factors involved in the general interconnection of the power sources and markets."

Making Lead Covered Cable

(Continued from Page 5)

This ram forces the soft lead out through the only available opening, which is the one around the die through which the core is passing. By using dies of different sizes, the thickness of the lead sheath may be changed. As the core is drawn through the press, the soft lead is forced around the core, continuing to do this as long as pressure is applied and as long as the core moves.

After the cable has gone through this machine and has a coat of lead on it, a rigid test is made for any faults that may occur. It is placed directly on a reel from the lead and moved to an inspection room by an overhead traveling crane.

When the cable has been thoroughly tested it is ready for shipment.

rent must pass through the wire into the screw eye and to the armature *B*, and out at *C*.

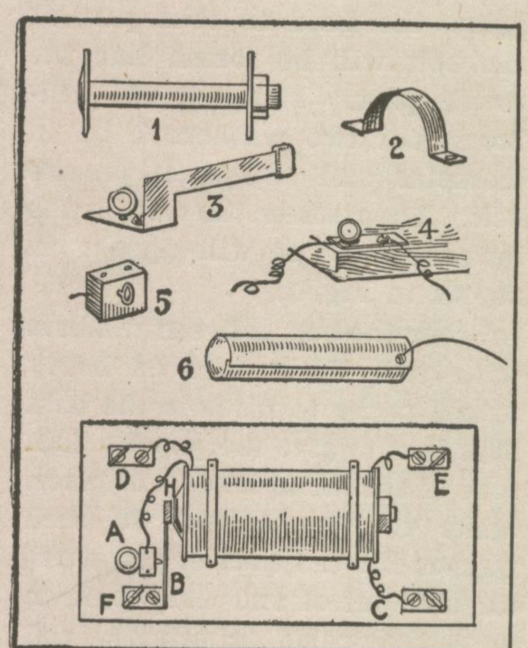
Three binding posts are made from small pieces of sheet brass or copper ⅜ in. wide and ¾ in. long and provided with two holes, to receive a brass screw and screw eye and washer, as shown in Fig. 4.

The binding posts are fastened at each corner of the base block and to *D* one end of the No. 30 wire is caught under the screw head. Another end is caught at *E*, and the remaining No. 20 wire is fastened at *C*.

When this apparatus is properly mounted, the armature should vibrate between the bolt head and the screw eye end against which it rests when not in action.

The wires from a dry cell are attached at *F* and *C*, and the current passing into the coil through *B* and *A* and out at *C* magnetizes the bolt and draws the lug *H* to the bolt head. As quick as this happens, however, the current is interrupted, for *B* is pulled away from *A* and opens the circuit. The bolt becomes demagnetized, the lug *H* is released, and the circuit is again closed through *A*. This is repeated many times in each second, producing an interrupted current in the primary coil. This induces a current in the secondary coil of higher voltage, due to the increased number of turns.

The handles shown in Fig. 6 are made from tin and are 3 in. long and ¾ in. in diameter. These are attached to *D* and *E* by flexible copper wire.



The shocking coil and its various parts

The intensity of the shocking current may be varied somewhat by turning the screw eye at *A*.

To Drive a Nail in Plaster

If a nail is heated either in boiling water or over a flame it can be driven into plaster without chipping the plaster. If you use a flame, be careful not to heat the nail too much.

Contributed by G. W. Greene.

A SIMPLE "SHOCKING" COIL

By Harold Hymans

OBTAIN a carriage bolt 3 in. long and ¼ in. in diameter and file away the square shoulder below the head so that part of the bolt will be round, like the lower part. From stout cardboard cut two washers 1 in. in diameter and slip them on the bolt. Then screw the nut on the lower end so it will appear as shown in Fig. 1.

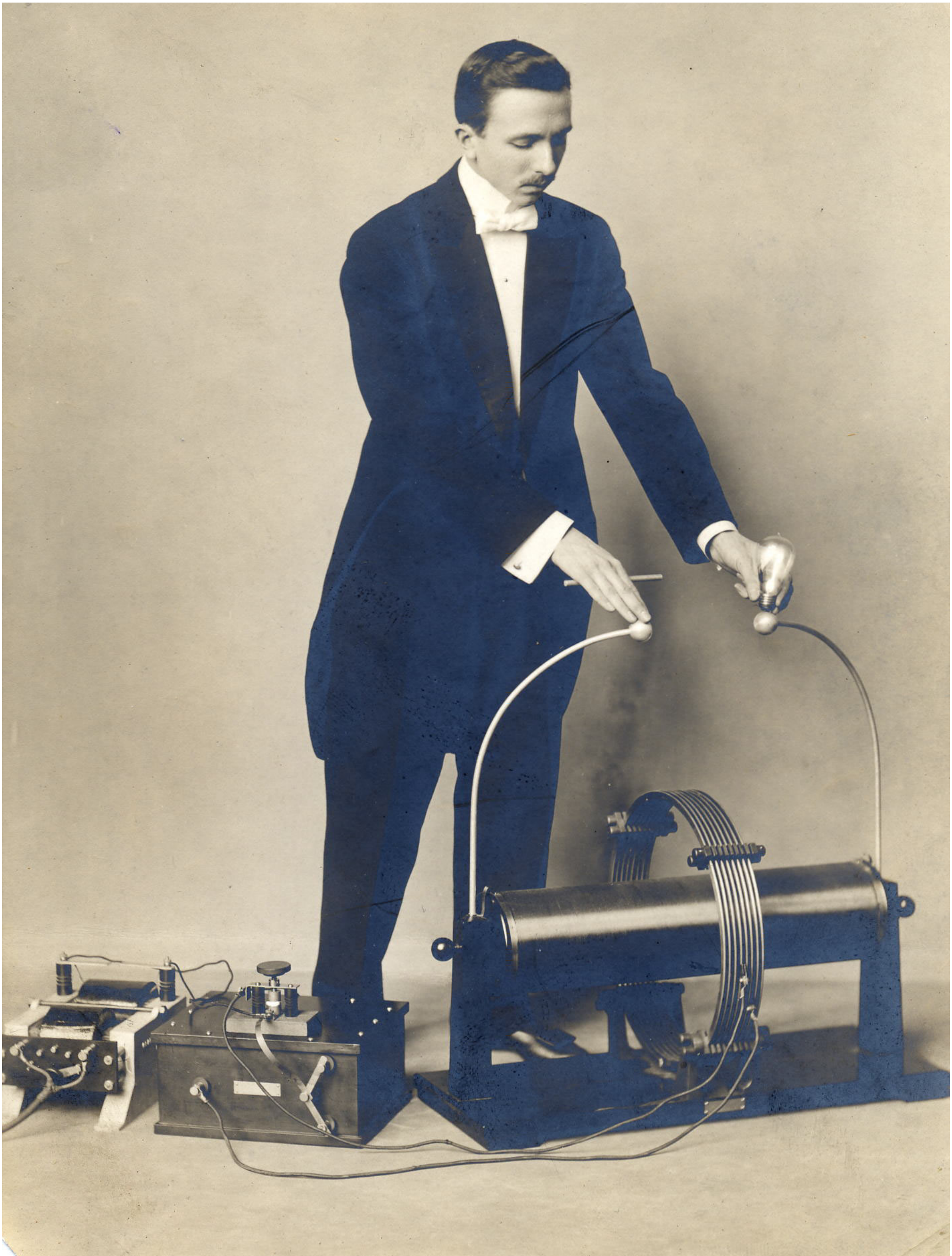
Cover the bolt between washers with two thicknesses of heavy waxed paper to insulate the bolt. It is best to give the paper a thin coat of shellac to keep it in place. Make two small holes in each washer for the ends of the wires to come out of and then begin to wind the inside or primary coil by using No. 20 cotton insulated copper wire. Wind this on in three layers the same as thread around a spool. Over the last layer put two thicknesses of waxed paper and cover with a thin coat of shellac. The ends of the wires will project from the washers at opposite ends of the bolt, and they should be about six inches long. A current of electricity from a battery sent through these wires will magnetize the bolt.

For the outside or secondary coil obtain some No. 30 double insulated copper wire and wind eleven layers over the first coil, taking care to get the wire on evenly and smooth. Cover the last layer with a thickness of waxed paper shellaced to keep it in place. This covering protects the wire from chafing. Care must be taken in winding the wire to see that the insulation is not scraped off, as this will short circuit the coil and the shocking current will not be as strong.

From wood ¾ in. thick cut a base block 3½ in. wide by 5 in. long and with straps a quarter of an inch wide, as shown in Fig. 2, screw the coil fast to the middle of the base block as shown in the drawing of the induction coil.

From heavy tin cut and shape an armature as shown in Fig. 3 and provide it with holes so it may be screwed to the base board. The armature is 1¾ in. long and at its loose end several wraps of tin are made and beaten flat and the tip end of the arm can be bent around to prevent the lug from flying off.

A small piece of wood in which a screw eye is placed (Fig. 5) should be made fast to the base block to occupy the position shown at *A* and to this one end of the heavy wire is attached by passing it through a small hole so that the screw eye will bear on it to make the contact, for the cur-



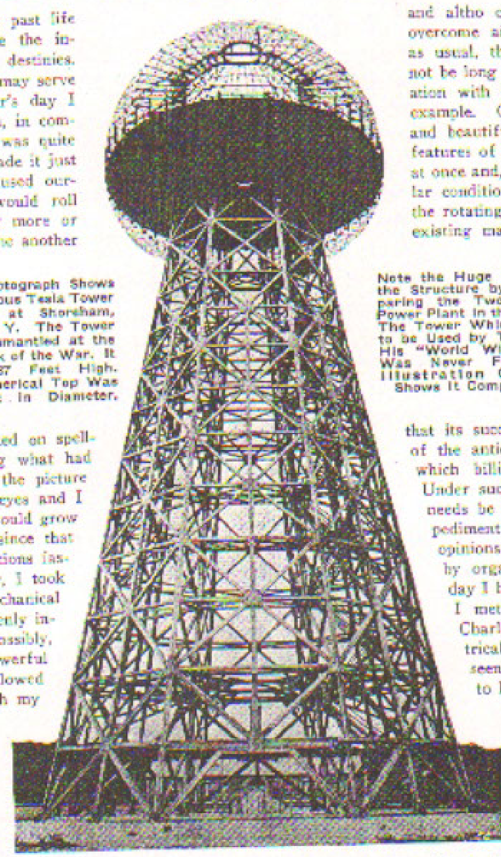
My Inventions

By Nikola Tesla

V. The Magnifying Transmitter

As I review the events of my past life I realize how subtle are the influences that shape our destinies. An incident of my youth may serve to illustrate. One winter's day I managed to climb a steep mountain, in company with other boys. The snow was quite deep and a warm southerly wind made it just suitable for our purpose. We amused ourselves by throwing balls which would roll down a certain distance, gathering more or less snow, and we tried to outdo one another in this exciting sport. Suddenly a ball was seen to go beyond the limit, swelling to enormous proportions until it became as big as a house and plunged thundering into the valley below with a force that made the ground tremble. I looked on spellbound, incapable of understanding what had happened. For weeks afterward the picture of the avalanche was before my eyes and I wondered how anything so small could grow to such an immense size. Ever since that time the magnification of feeble actions fascinated me, and when, years later, I took up the experimental study of mechanical and electrical resonance, I was keenly interested from the very start. Possibly, had it not been for that early powerful impression, I might not have followed up the little spark I obtained with my coil and never developed my best invention, the true history of which I will tell here for the first time.

This Photograph Shows the Famous Tesla Tower Erected at Shoreham, L. I., N. Y. The Tower Was Dismantled at the Outbreak of the War. It Was 187 Feet High. The Spherical Top Was 68 Feet In Diameter.



Note the Huge Size of the Structure by Comparing the Two-story Power Plant in the Rear. The Tower Which Was to be Used by Tesla in His "World Wireless," Was Never Finished. Illustration Opposite Shows It Completed.

Scrapping the World's Engines.

"Lionhunters" have often asked me which of my discoveries I prize most. This depends on the point of view. Not a few technical men, very able in their special departments, but dominated by a pedantic spirit and near-sighted, have asserted that excepting the induction motor I have given to the world little of practical use. This is a grievous mistake. A new idea must not be judged by its immediate results. My alternating system of power transmission came at a psychological moment, as a long-sought answer to pressing industrial questions, and altho considerable resistance had to be overcome and opposing interests reconciled, as usual, the commercial introduction could not be long delayed. Now, compare this situation with that confronting my turbine, for example. One should think that so simple and beautiful an invention, possessing many features of an ideal motor, should be adopted at once and, undoubtedly, it would under similar conditions. But the prospective effect of the rotating field was not to render worthless existing machinery; on the contrary, it was to give it additional value. The system lent itself to new enterprise as well as to improvement of the old. My turbine is an advance of a character entirely different. It is a radical departure in the sense that its success would mean the abandonment of the antiquated types of prime movers on which billions of dollars have been spent. Under such circumstances the progress must needs be slow and perhaps the greatest impediment is encountered in the prejudicial opinions created in the minds of experts by organized opposition. Only the other day I had a disheartening experience when I met my friend and former assistant, Charles F. Scott, now professor of Electrical Engineering at Yale. I had not seen him for a long time and was glad to have an opportunity for a little chat at my office. Our conversation naturally enough drifted on my turbine and I became heated to a high degree. "Scott," I exclaimed, carried away by the vision of a glorious future, "my turbine will scrap all the heat-engines in the world." Scott stroked his chin and looked away thoughtfully, as though making a mental calculation. "That will make quite a pile of scrap," he said, and left without another word!

IMAGINE a man a century ago, bold enough to design and actually build a huge tower with which to transmit the human voice, music, pictures, press news and even power, thru the earth to any distance whatever without wires! He probably would have been hung or burnt at the stake. So when Tesla built his famous tower on Long Island he was a hundred years ahead of his time. And foolish ridicule by our latter day arm-chair "savants," does not in the least mar Tesla's greatness.

The titanic brain of Tesla has hardly produced a more amazing wonder than this "magnifying transmitter." Contrary to popular belief his tower was not built to radiate Hertzian waves into the ether. Tesla's system sends out thousands of horsepower thru the earth—he has shown experimentally how power can be sent without wires over distances from a central point. Nor is there any mystery about it how he accomplishes the result. His historic U. S. patents and articles describe the method used. Tesla's Magnifying Transmitter is truly a modern lamp of Aladdin.

EDITOR.

"Aladdin's Lamp".

These and other inventions of mine, however, were nothing more than steps forward in certain directions. In evolving them I simply followed the inborn instinct to improve the present devices without

(*Continued on page 148*)

Mr. Tesla's articles started in our February issue

HIS PHOTOGRAPH OF A MODEL SHOWS HOW THE TESLA TOWER BUILT ON LONG ISLAND, EIGHTEEN YEARS AGO, WOULD HAVE OOKED COMPLETED. FROM ITS APPEARANCE NOBODY WOULD INFER THAT IT WAS TO BE USED FOR THE GREAT PURPOSES WHICH ARE SET FORTH IN HIS ACCOMPANYING ARTICLE.